MEMORANDUM.

This electrical handbook is one of a series of ten similar handbooks prepared under the auspices of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS by the local Reception Committees in the Cities of Boston, New York, Schenectady, Montreal, Niagara Falls, Chicago, St. Louis, Pittsburg, Washington, and Philadelphia. These are the stopping places on the circular tour organized by the INSTITUTE for the reception and entertainment of its foreign guests who visit the United States in connection with the International Electrical Congress at St. Louis, September 12th to 17th, 1904. It is hoped in these handbooks to present short historical sketches of the cities visited and a rapid survey of the power plants and important electrical industries along the route.

Pittsburg. **No. 284**

Westinghouse Works, East Pittsburg, Pa.

ELECTRICAL HAND-BOOK

THE PITTSBURG ELECTRICAL HAND-BOOK

Being a Guide for Visitors from Abroad Attending the International Electrical Congress, St. Louis, Mo. September, 1904

Pittsburg

Published under the auspices of
The American Institute of
Electrical Engineers
1904

PREFACE

The Pittsburg Electrical Hand-Book is one of a set of ten describing the electrical interests of American cities including Boston, New York, Schenectady, Montreal, Niagara Falls, Chicago, St. Louis, Washington and Philadelphia. These books are prepared especially for the information and guidance of visiting members of the Institution of Electrical Engineers, Great Britain and of the Associazione Elettrotecnica Italiana and members of other foreign electrical societies who visit America to attend the International Electrical Congress at St. Louis, and are the guests of the American Institute of Electrical Engineers on a tour of visitation to the cities above named. The Hand-Books are prepared under the general direction of the Institute by the local committees in the several cities.

The Pittsburg Electrical Hand-Book contains a general description of Pittsburg as a manufacturing and commercial center. The city claims one of the largest electrical manufacturing establishments in the world and one which, starting in the earliest years and maintaining its individuality and integrity, stands as one of the oldest electrical companies of its kind. Pittsburg also is prominent in pioneer work along the principal branches of electrical advancement. Many of the systems which are

now most common and the types of apparatus which are most widely used had their beginning in this city.

Sketches of a number of Pittsburg electrical operating companies show, in the progress made by these companies, the rapid advancement in the electrical art, which has contributed materially to the importance of the city as a great manufacturing center. The articles which describe other than manufacturing features, such as parks and railroads, the observatory and the Carnegie institute, show that there is much in Pittsburg which is not typified by its smoke.

The various parts of this book have been prepared by representatives appointed by the interests which are described. The writers in general have not merely considered present equipments and facilities but have taken more or less of a perspective view so that their articles are interesting accounts of the steps in the development which have brought about the present conditions. The electrical industry has quickly taken its place among the principal industries of Pittsburg and unless there is to be a radical change in the rate at which progress and growth have taken place, the Pittsburg Electrical Hand-Book of a decade hence will take the figures given in this book as the starting point from which to mark subsequent development.

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PITTSBURG BRANCH

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The Pittsburg Branch comprises one hundred and twenty-five members of the Institute residing in Pittsburg and vicinity. Monthly meetings are held and the papers read at the general meeting are presented and discussed, supplemented from time to time by new papers. The meetings are held in the assembly hall of The Electric Club, located in Wilkinsburg, an eastern suburb of Pittsburg.

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PITTSBURG

"The World's Work Shop"

General Sketch — Historical — General Account of Pittsburg's Industries and its Present Rank and Position

IF YOU take up the map of the United States you will find upon the great highway of traffic and transportation from the East to the West, Pittsburg, located at the "Toll Gate" beyond which the arteries of travel diverge in all directions over the great West. "Here," said George Washington upon his visit to the head-waters of the Ohio, "is undoubtedly the 'Gate of the West,' and a settlement built here is bound to grow and flourish beyond the imagination of men." And his prophetic vision has come to a partial realization as well by unique geographical position as by the possession of mineral wealth of which Washington had no knowledge.

Pittsburg is the World's Workshop. It is the hub on which the wheel of American Industries has been wrought, and each spoke in this wheel represents a magnificent activity whose distinctive greatness may be approached, but is not surpassed anywhere.

Within the precincts of Pittsburg are located upwards of one hundred manufacturing companies, which represent an invested capital of two thousand million dollars, employing more than 500,000 workers. The prod-

ucts manufactured by these companies cover a wide variety. Among the most important are steel, iron, plate glass, tableware, window glass, tin plate, steel cars, air brakes, electrical machinery, steam engines, locomotives, steel and wrought iron pipe, coal, coke, fire brick, clay, cork, petroleum, pickles and white lead.

At the head and front of the iron and steel industry of the world admittedly stands the United States Steel Corporation, the parent company of which, the Carnegie Steel Company, is located in Pittsburg. As a manufacturer of iron, structural steel, armor plate and steel rails, this establishment ranks before all others. Another company, the Jones & Laughlin Steel Company, the largest independent rival of the Carnegie Company, also has its home here. To give a comprehensive idea of the importance of Pittsburg as the iron and steel producing center of the world, the following figures for the year 1903 will no doubt prove interesting:

Number of furnaces, 40.
Rolling Mills and Steel Works, 66.
Production of pig iron, 4,260,769 tons.
Production of Bessemer steel, 3,094,175 tons.
Production of open hearth steel, 2,503,245 tons.
Production of crucible and other steel, 62,888 tons.
Total production of steel, 5,660,308 tons.
Production of all kinds of rails, 712,286 tons.
Production of structural shapes, 773,144 tons.

The figures of coal production for the Pittsburg district are equally amazing. During the year 1903 there

Homestead Mills, Carnegie Steel Co

was a total output of 22,000,000 tons. Of this amount 4,000,000 tons were used for home consumption alone; the rest was shipped by rail or river to other parts of the country. While it is difficult to determine positively the coal deposit of the Pittsburg coal mining district, the amount yet unmined is estimated at 10,000,000,000 tons.

The Pittsburg district leads the world in the production of coke. At the end of the year 1903 there

Old Block House

An early fort for defense from Indian attacks, which is still standing in Pittsburg near the confluence of the rivers

were in operation 28,092 coke ovens, which shipped 13,345,230 tons of product. The average price of coke for that year being $3.00 per ton, it will be seen that the gross revenue of the Pittsburg coke industry represented the enormous sum of $40,035,690.

Pittsburg is likewise the center of the glass industry of the world, producing window glass, plate glass, table ware, tumblers, chimneys, etc. In the manufacture of

table ware, bottles, tumblers and the like are engaged 1,529 pots; in the window glass trade 900 pots, not to mention the tank factories of the American Window Glass Company.

During 1903 America produced 27,000,000 feet of plate glass, which means this amount of plate glass was made in and around Pittsburg, where ten of the twelve factories manufacturing this product are located.

Lamp chimneys made in Pittsburg during one year, if laid end to end, would stretch a distance of 12,000 miles. The bottles made here during the same time, if laid end to end, would measure 16,000 miles.

The city ships every year approximately 2,000,000 boxes of window glass from local factories, equal to 90,000,000 feet or 62,000 tons.

Another important Pittsburg industry is the lumber trade in which some twenty-five firms are engaged, producing annually 800,000,000 feet of lumber at an estimated value of $20,000,000.

Pittsburg easily leads all other cities in the manufacture of white and red lead. With manufactured lead, such as is required by painters every day, selling at a

Pittsburg in 1800

wholesale rate of $110 to $125 per ton, one can readily see that when carload shipments are made considerable money changes hands. At least 500 carloads of lead are shipped from Pittsburg every year. The lead manufactured in Pittsburg has the call in the market

Carnegie Library

and each of its manufactories has all the trade it can handle, at better figures than are offered the manufacturers in other localities. The reason given for this is that the trade early ascertained that Pittsburg was making a lead that had all the elements of durability, with the advantage of a moderate price. The trade grew from a small beginning until now the city leads in the manufacture of painters' lead.

Pittsburg was the scene of the earlier development of two industries which were later transferred, in whole or in part, to Niagara Falls, as they are large users of electric power. The process of making carborundum, the modern abrasive, was the work of a Pittsburg inventor. The first commercial production of aluminum by the Hall process was carried on for a number of

Allegheny County Court House

years in Pittsburg. This industry has been developed by the Pittsburg Reduction Company, its product has been reduced in price from four or five dollars per pound until it now competes with other metals and is largely used instead of copper for electric conductors. The metal is now produced at Niagara Falls and in Canada, while the rolling of sheets and the drawing of wire is carried on at New Kensington, near Pittsburg.

Pittsburg has the largest pickling and preserving works in the world. It employs 2,400 hands and uses

Carnegie Steel Company

the crops from 17,000 acres of land. The main plant in Pittsburg occupies a floor area of about thirteen acres, and in addition the company operates eight branch factories situated in States which offer specially attractive conditions for growing products peculiar to its business. The goods are distributed in this country through branch houses in all the principal cities, and its export traffic is handled through New York and branch houses in London. The firm owns and operates a glass works to partly supply the bottles used.

The financial resources of Pittsburg are in keeping with its commanding position in the industrial world. In this respect it is the fifth city in America. In 1903 there were located within its precincts 174 banks with a total capital of $63,586,322, a surplus of $75,638,244 and total resources of $473,493,980.

The name of Pittsburg has been linked with that of petroleum ever since that fluid was first discovered in large wells within its suburbs in 1859. The oil was floated down the Allegheny river to Pittsburg refineries and from there it was marketed the world over. The oil business has since developed into one of the most stupendous commercial enterprises in the world, and although oil is now found in many other places besides Western Pennsylvania, nevertheless Pittsburg is still the center of the petroleum market. All the machinery for oil well drilling whether used in Egypt, Russia, Siberia, Austria, France, Japan, Australia, or in Texas, is made and supplied by Pittsburg. To get an adequate idea of the enormous oil business of this district one must remember that the annual production of petroleum from the wells in the vicinity of the city amounts to about 50,000,000 barrels, representing $60,000,000.

Carnegie Steel Company

There is another natural product drawn from the bowels of the earth around this much favored city of Western Pennsylvania: that is natural gas. This fuel, discovered about twenty-five years ago, was not practically utilized until some five years later. Mr. George Westinghouse, recognizing the wonderfully economical possibilities of this marvelous gas, began to pipe it into the city for use in private houses and factories. Since then the business has reached a high state of development. There is now a capital of $40,000,000 invested in the natural gas business in Pittsburg. The fuel is brought to the city and distributed through 2,500 miles of pipe. The daily consumption amounts to 110,000,000 cubic feet, used in 500 factories and among 40,000 families.

Pittsburg was founded by the French, who, recognizing the strategic advantages of its location, erected a fort at the junction of the Allegheny, Monongahela and Ohio rivers, and called it Fort Duquesne. They held possession until driven out by the British and colonials, when the name was changed to Fort Pitt, from which grew Pittsburg.

Jones & Laughlin Steel Mills

The earliest settlers were largely Scotch-Irish and Germans, a hardy lot of energetic, thrifty artisans. Its location near three rivers naturally made boat building an early industry. In 1794 a regular line of boats was established between Pittsburg and Cincinnati. With the beginning of the nineteenth century the discovery of coal led to the building of rolling mills, foundries, glass houses, rail mills and machine shops.

In 1804 Pittsburg had a population of 1,500, in 1860 just before the civil war the census mark was 49,221. Ten years later the population had doubled, and since that time the increase has been so rapid that at the last official census it had reached the figure of 324,744 for the city proper, and approximately twice that number for Pittsburg and the immediate vicinity.

These figures refer to the corporate limits of the city of Pittsburg. If the population of the sister city of Allegheny and the immediate tributary towns be included as a part of Greater Pittsburg, the total population would approximate three-quarters of a million.

The foreign visitor who is accustomed to cities many of whose industries and whose public works date back centuries must not forget that there is in Pittsburg very little which attracts his attention, either manufacturing establishments, office buildings, residences, parks or boulevards which have not had practically their whole development within the past 10 or 15 years. As a matter of fact, an oldtime resident of Pittsburg who has been absent from the city for 15 years would find nearly as much that is new to him as a foreigner who visits the city for the first time.

George Westinghouse

DEVELOPMENT of an industrial community or of a great industry is sometimes the result of the concurrent effort of many men whose individuality is merged in a common result. Sometimes, however, there are men whose power as originators and as leaders impress their individuality upon all with which they come in contact. In the industrial development of Pittsburg and in the evolution of the electrical industry there is a man whose career has been one of leadership and who has expended his best energies in the development of manufacturing companies, whose organization and methods may be taken as approximating the ideal in the new industrial life which has grown up within the past twenty-five years. In its broadest sense the development of modern industry along right lines owes much to the example and the life work of George Westinghouse.

George Westinghouse, of German descent through the genealogy of his father, was born at Central Bridge, Schoharie County, New York, October 6, 1846, the son of George and Emeline (Vedder) Westinghouse. His descent through his mother is from Dutch-English ancestry, and he inherited not only the sturdy character of the Holland Puritans, but also their religious tendencies and their capacity for hard work, and in addition a preference for the fine arts. His father was a manufacturer in Schenectady and it was in his shops that the younger George acquired much of his skill as a mechanic. His early education was limited to the common schools and he became an inventor at the age of fifteen, conceiving something entirely new in the form

of a rotary engine, which he constructed with his own hands, even then accustomed to the use of tools. Although only a boy during the civil war, his large stature enabled him to gratify his desire to fight for the Union, and he has the unique record of having served in the infantry and cavalry of the army, and, for the last year of the war, as an engineer officer in the navy, resigning when the fighting was over.

After a short stay at Union College (which has honored itself, since he became famous, by conferring a degree on him), he began active business life in the exploitation of a railroad switch which he had invented. This brought him in touch with railroad problems, of which the most important was the discovery of an efficient power brake. While studying the problem, the successful use of compressed air in the construction of the Mont Cenis tunnel was made public. He alone grasped the hint. His mind had already formulated the mechanism. Here was the power — compressed air. Thus, in 1868, he invented the air brake, which is undoubtedly the greatest advance in railroading since Stephenson's use of forced draft in the Rocket. We cannot go into the story of the introduction of the brake and of its improvement, but it is to be noted that Mr. Westinghouse has always studied to improve it and his later inventions of the "triple-valve" and the quick action brake are almost as epoch-making as that of the air brake itself. It is not exaggerating to say that these inventions have made modern, high-speed railroading possible and safe.

Mr. Westinghouse is not only a mechanical genius and inventor, but a skillful executive and financier. As soon as he had the brake well developed, he organized a factory for its manufacture, which has grown to the great works at Wilmerding, Pa., one of the most remarkable examples of highly specialized and efficient manufacturing in the world. It is worth noting, in this connection, that in his Air Brake Works, as far back as the 70's, Mr. Westinghouse introduced the Saturday

half-holiday and 54-hour week, a practice followed in all his later works.

Applying the experience gained in the use of compressed air with the brake to his old work with switches, led to the pneumatic switch and signal, now so common, and this line of industry has developed into another of his works, the Union Switch and Signal Company. These automatic signals have enormously increased the capacity of the railroads, one prominent official saying that five times as many trains could be operated on tracks protected by them as on those unprotected.

With the use of electricity to operate the valves in the pneumatic system, he was brought to study this comparatively new agent, and out of this has grown the greatest of his companies, the Westinghouse Electric and Manufacturing Company. One of the qualities for which Mr. Westinghouse is noted among those who know him best is his remarkable foresight. Twenty years ago, he seems to have foreseen the tremendous possibilities of electrical developments and even the line along which they would proceed. Nearly all other workers in the electrical field were developing direct current, but he saw that the transmission losses would keep this form within narrow limits. Alternating current would take care of the transmission, but a means must be provided for readily changing the high pressure needed for transmission to the low pressure needed for application. The Gaulard and Gibbs transformer patents offered a solution; these he bought, and started the Electric Company. One more thing was needed for complete success, a simple and reliable motor. This was supplied by Tesla, who was backed by Mr. Westinghouse while working it out.

The story of the fight to introduce alternating current which was carried on by Mr. Westinghouse single-handed against incredible opposition, is as fascinating as a romance, but space limits forbid going into details. We may only mention the lighting of the Chicago Fair

and the great Niagara Plant as among his earliest triumphs. He has the satisfaction now of seeing his ideas approved by the whole electrical industry and what was a feeble infant grown to a giant. The great dynamos for the Elevated and Underground roads in New York, and for the Underground road in London are among his latest triumphs, and the recent perfection of the alternating-current single-phase railway motor has added yet another victory to the alternating system.

Besides the work thus far described, Mr. Westinghouse has taken a foremost part in the development of the gas engine and the steam turbine, which are built by the Westinghouse Machine Company. He was also the moving spirit in the exploitation of natural gas in the Pittsburg district, his special merit coming from working out its piping over long distances, which was at first thought impossible.

Works for the manufacture of the air brake have long been established in England, France and Germany, followed by Electric Works in France, and more recently by the great works of the British Westinghouse Electric and Manufacturing Company at Manchester, England, which in the first year of operation employed about 5,000 men, and the Canadian Westinghouse Company at Hamilton, Ont. In all, Mr. Westinghouse is President of nearly a score of companies employing about 30,000 people, and representing a capital of nearly $100,000,000.

With all this wonderful achievement to his credit, the man himself is modest and unassuming. Indeed, owing to his great dislike of anything like personal advertising, and his absolute refusal until very recently to let his portrait be published, only those who had met him personally knew his appearance. He is a man of very attractive personality and charm of manner, and of large and vigorous physique. It is obvious that only a man of tremendous capacity for work and of splendid health could have accomplished all that he has, and even now he works harder than any of his lieutenants.

On August 8th, 1867, George Westinghouse was married in Brooklyn to Margaret Erskine Walker, and their family life has been almost ideal. They have one son, George Westinghouse, Jr., who is now a student at Yale. Numerous business cares leave Mr. Westinghouse little time for social enjoyment, which thus devolves largely on Mrs. Westinghouse, who, in all of her beautiful homes, is the ideal hostess, gracious and charming, and possessed of that rare tact which, without apparent effort, makes every guest feel thoroughly at home and draws out his best efforts towards the general entertainment, assured of a sympathetic audience. The winter residence is the Blaine House on Dupont Circle in Washington, and the summer home the beautiful estate of Erskine Park at Lenox, Massachusetts. They still retain their fine old home in Pittsburg, among the first of the large houses in what is now the residential district.

There have been conferred on Mr. Westinghouse the decorations of a number of foreign orders, including the Legion of Honor, the Royal Crown of Italy, and the Order of Leopold of Belgium. He is also one of the two living honorary members of the American Association for the Advancement of Science, and an honorary member of the American Society of Mechanical Engineers.

Among all the noted citizens of Pennsylvania, it is doubtful if there is another who has done so much for industrial development as George Westinghouse. His factories produce apparatus which generate power or control its use and thus become effective instruments in doing the World's work. His epoch-making inventions have done so much to save and protect life and to make it more worth living, that they justly entitle his name to a high place among the benefactors of the race.

PITTSBURG ELECTRICAL AND ALLIED INDUSTRIES

Works of the Pittsburg Meter Company

Westinghouse Industries

AMONG the leading manufacturing enterprises of Pittsburg, whose products have contributed so largely to the world-wide reputation of the city, the Westinghouse interests occupy a most prominent position. They include the Westinghouse Air Brake Company, manufacturers and original inventors of that brake which, nearly forty years ago, gave such a wonderful impetus to railroad development throughout the world, and which is now used in every civilized country on the globe where railroads are the means of transportation; the Westinghouse Electric and Manufacturing Company, makers of apparatus for the generation and distribution of electric light and power, pioneers in the development of the alternating system, patentees and owners of the Tesla system of polyphase power transmission and manufacturers of the largest dynamos the world has ever known; the Westinghouse Machine Company, manufacturers of high grade steam engines, gas engines, steam turbines and mechanical stokers; the Union Switch and Signal Company, manufacturers of signal and safety devices employed in the operation of the large railroads of this country as safeguards to life and property; the Sawyer-Man Electric Company, makers of incandescent lamps; Westinghouse, Church, Kerr & Company, engineers and contractors; the Pittsburg Meter Company; the Nernst Lamp Company; the Cooper-Hewitt Electric Company; the R. D. Nuttall Company; the Westinghouse Traction Brake Company; the American Brake Company; the Bryant Electric Company; Canadian Westinghouse Company, Limited; the British Westinghouse Electric

Sawyer-Man Electric Co., New York City

and Manufacturing Company; the Westinghouse Brake Company, Limited, of London, Paris and Hanover; Societe Anonyme Westinghouse of France; Westinghouse Electricitats-Actiengesellschaft of Berlin, Germany; and Westinghouse Company, Limited, of Russia.

The various divisions of this group of interests located in the city of Pittsburg and its suburbs, cover an area of several hundred acres and provide occupation for some 20,000 employees. In construction and equipment, Westinghouse workshops represent the most modern development and the latest improvements in tools, labor-saving appliances, operating facilities and general organization.

Bryant Electric Co., Bridgeport, Conn.

The welfare of employees while at work has been thoroughly considered in the construction of the plants; ventilation and sanitation have been subjects of careful study and intelligent effort. It is generally recognized among authorities on construction that the Westinghouse works may be justly regarded as models for factory builders the world over.

The total capitalization of the various Westinghouse interests represents approximately the sum of $100,000,000; the annual output, $75,000,000.

These great industries have sprung from small beginnings; their origin is equally interesting because they have all been created and developed under the guidance of one master mind.

As a young man, just past his majority, George Westinghouse laid the foundation for this great industrial structure in a small shop at the corner of Twenty-fifth Street, Pittsburg, where, with less than one hundred workmen, he began the manufacture of the now world-renowned Westinghouse Air Brake, the first patent for which had been issued to him by the United States Patent Office on April 13th, 1869. That same year the Westinghouse Air Brake Company was organized, and active work of manufacture was begun soon after.

Canadian Westinghouse Co., Ltd.

The introduction of this air brake marked an epoch in the history of railroad development, and made possible the marvelous advance of the past few decades. The growth of the Air Brake Company has kept pace with the extension and expansion of the railway business, and today practically the entire railway system of the world is equipped with the products of the factory near Pittsburg, or its branches in Canada, England, France, Germany and Russia.

That the Westinghouse Air Brake has never been supplanted by a rival nor defeated by a competitor, but has for nearly forty years maintained an impregnable position, is a unique triumph for the inventive genius which created it, and a proof of its inestimable value and efficiency.

In 1890 the works of the Air Brake Company were removed to Wilmerding, fourteen miles from Pittsburg. Since then additions have been made from time to time as the business demanded, until today the company employs about 3,000 mechanics and laborers.

The Westinghouse Machine Company was organized in 1881 for the purpose of manufacturing the high speed steam engine designed by Mr. H. H. Westinghouse. It began operations in the same shop in which the Air Brake Company had started, the latter having moved to a new factory on Robinson Street, Allegheny.

The engine business made rapid strides and the demand for this factory's product came from all parts of the world. In 1894 the development of gas engines of larger capacity was commenced, as it was recognized that the operation of electric generators offered a great field for such machines. A gas engine department was established; and almost immediately met with such success that the old factory became inadequate and the new works in East Pittsburg were constructed.

About this time the company took up the manufacture of heavy duty Corliss engines. Its progress in this field may be judged from the sizes of the engines manufactured, some of which range up to 6,500 IHP.

Arrival of Employees on Morning Train

In 1896 Mr. Westinghouse made arrangements with Mr. Parsons of England, the inventor of the steam turbine which bears his name, by which the Machine Company acquired the right to manufacture these turbines for the United States. The work of further development was begun at once with the result that the Westinghouse-Parsons turbines to the extent of hundreds of thousands of horse power are now in operation. At the present time the factory of this company in East Pittsburg has about 2,500 operatives.

The Union Switch and Signal Company was organized in 1883 for the manufacture of the electric pneumatic signaling devices invented by Mr. Westinghouse. Operations were begun in a modest way in a small machine shop on Garrison Alley, Pittsburg; but soon extension had to be made owing to the rapid growth of the business, and in 1886 the company moved to Swissvale, the site of its present works, which were erected in 1901. About 1,000 operatives are now employed. The prospects of this company are exceedingly bright, as the great railroads have only recently become thoroughly alive to the fact that the employment of safety devices results in a saving of equipment as well as the preservation of life.

Four of the Cranes in Section B, Westinghouse Electric & Mfg. Co.

The origin, growth and development of Westinghouse Electric and Manufacturing Company furnishes one of the most phenomenal examples of American industrial enterprise. Although it is less than twenty years since the company was organized, its present works in East Pittsburg are in size, construction, equipment, operating facilities, and productive capacity, among the most noted in the land. Its product is known the world over and recognized as standard in the field of electric lighting, railway and power transmission and distribution.

In 1884, Mr. Westinghouse, then in Europe in the interests of the air brake, had his attention called to the alternating system of electrical distribution, the patents for which were owned and controlled by Messrs. Gaulard and Gibbs. With characteristic foresight he acquired these patents, and on his return to America, began the design and construction of alternating current machinery. The Electric Company was organized in 1886, and in October of that year, the first alternator was installed in Greensburg, Pa., and electric lighting by the alternating system became an accomplished fact. It was not long before the older companies, who exploited the direct current system, began to feel the competition of the younger rival, and then began a warfare which has probably never been equalled in the history of industrial competition. Every conceivable obstacle was put in the way of the new company but all in vain, and the alternating current won its way to its present proud position, the foremost system in electrical industry.

In 1888 Nikola Tesla, who had recently discovered the principle of the rotary magnetic field, became associated with the company, and thereby secured the means and facilities for further experiment.

Following the development of the polyphase motor, the polyphase system of electrical transmission has secured a notable triumph in that it is employed in all long distance plants for power transmission, in many

railway systems which ultimately supply direct current and in central electric light and power stations to such an extent that the output of polyphase alternators in these stations is more than double that of direct current constant potential dynamos.

In the application of electricity to street railway service the Westinghouse Company has taken a conspicuous part, culminating in the recent production of a practical and successful alternating current, single-phase railway motor.

The little machine shop of 1886 soon became too small and extensions and additions followed each other in rapid succession. The buildings in Allegheny abandoned by the Air Brake Company were transformed into a department of the Electric Company. But more room was needed and in 1894 the first portion of the present works in East Pittsburg was erected. At that time the company's pay roll contained nearly four thousand names. But its growth had not reached its limit; in fact at East Pittsburg the real development of the company had but begun. From year to year the business grew and additional buildings were constructed; a factory in Newark, N. J., was added for the manufacture of detail apparatus, and more recently, extensive works have been erected at Havre, France; Manchester, England, and Hamilton, Canada, and the companies of Russia and Germany were organized and developed.

Thus from a small beginning in the little shop on Twenty-fifth Street, Pittsburg, in 1869, has grown a great family of industries united in a common parentage and guided by one master spirit. The various Westinghouse organizations number over 30,000 workers, the productions of whose hands and brains can be found in every country of the world. Wherever human enterprise and activity have utilized the energy of compressed air, steam and electricity, there can be found the products of the Westinghouse Industries.


WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

Westinghouse Electric & Mfg. Co.

RAPID growth of large enterprises and institutions is characteristic of things American. That rapid development is not inconsistent with solidity and strength is clearly illustrated in the history and by the present standing of the Westinghouse Electric and Manufacturing Company, the largest of that group of Westinghouse industries whose position in the manufacturing and engineering world is so commanding and secure.

Organized in 1886 and starting business with a force of but 200 employees, in a factory providing a working floor space of less than 50,000 square feet, this company, under wise and skillful leadership, has gone steadily forward, its progress marked by great commercial courage, farsighted appreciation of industrial requirements, the highest degree of technical skill, and engineering achievements which command the respect and admiration of the world. In the short space of eighteen years Westinghouse ideas have permeated every branch of electrical development, Westinghouse products have been applied to nearly every mechanical industry and the name of the great leader has become familiarly known in every quarter of the globe.

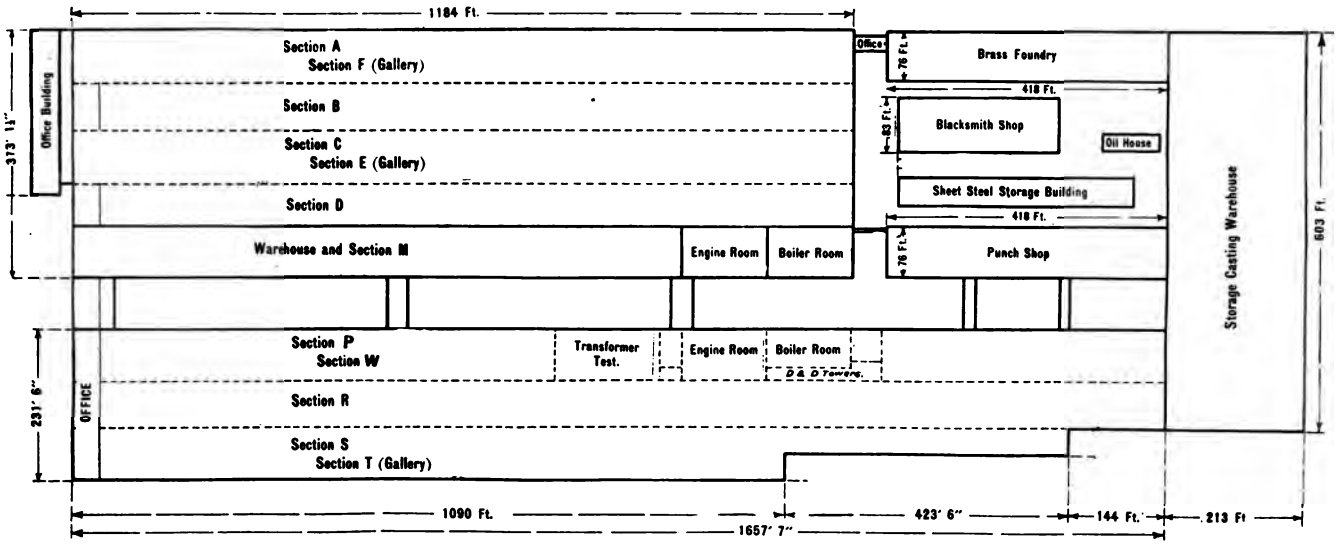
At the present time the main works of this company, which are located at East Pittsburg, twelve miles east of Pittsburg, in the Turtle Creek Valley, cover forty-seven acres of ground, provide an available floor space of over 2,000,000 square feet and give employment to nearly 9,000 operatives, a large proportion of whom are skilled mechanics or trained engineers. Branch works in Allegheny, Pa.; Cleveland, Ohio, and

Newark, N. J., swell the total number of employees to approximately 12,000. This estimate does not include the closely related industries whose operations are directly controlled by the Electric and Manufacturing Company; such companies as R. D. Nuttall Company of Pittsburg, Pa.; the Sawyer-Man Electric Company of New York City; the Bryant Electric Company and the Perkins Electric Switch Manufacturing Company of Bridgeport, Conn.

The Works

The East Pittsburg Works are, in construction, equipment and operation, models of American manufacturing enterprise. They were designed to secure the highest productive efficiency and provide for a natural increase and development. So wisely were the plans conceived that the abnormal growth and expansion of the past eight years has not resulted in confusion or radical change, but each addition has been made along

Armature Winding Department, Section B



WORKS OF WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, EAST PITTSBURG, PA.

Sections P, W, R, S and T comprise the new East Shop Sections A, F, B, C, E, D and M comprise the Main Shop –Sections run north and south with the office buildings at the south end of the works.

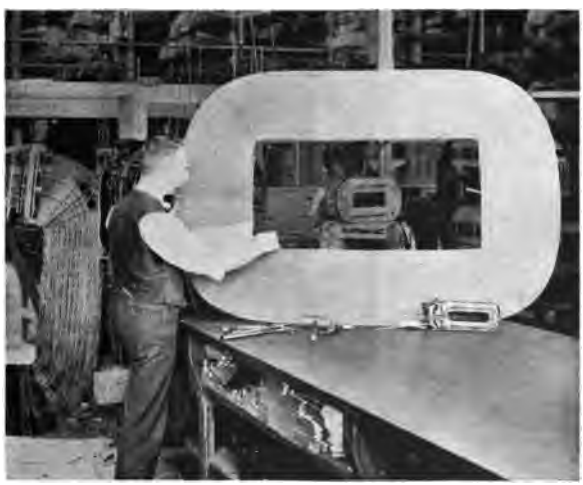
prearranged lines and has fitted in the general scheme originally outlined. In the plan of the buildings, arrangement of departments and systematic conduct of the work, there is present a unity of purpose coupled with a loyal co-operation which is bound to bring the best results. The spirit of the leader imbues the entire organization and its inspiration is felt by every employee from manager to apprentice. A centralized responsibility directs and controls, competent assistants execute, and trained and skillful artisans perform the varied operations of manufacture. Implicit obedience to authority is demanded and cheerfully given, but each operative is granted a freedom of action and method commensurate with his ability and responsibility. There is no suppression of the individual but each working unit is developed and encouraged to the utmost endeavor. All are working to a definite end in an harmonious and honorable relation.

A general view of the works is shown as the frontispiece. The main machine shop, which measures, ap-

Large Punch driven by a Type C Induction Motor

proximately, 1,200 feet in length by 300 feet in width, is divided into four parallel aisles or bays, each forming a distinct section or department designated by letters: — section A, section B, etc. Each section is organized and equipped for the production of work of a particular character. Section A, located on the extreme left as one enters the building, is devoted to the manufacture of street railway motors, both alternating and direct current; section C to the production of alternating and direct current generators and motors of capacity less than 100 KW, and in sections B and D larger machines are constructed, the latter section especially being equipped with tools of gigantic size capable of handling heavy material of large dimensions. Each bay is equipped with overhead electric cranes which traverse the entire length of the building. The cranes vary in capacity from ten to fifty tons.

In all departments production is carried on with a minimum handling and transportation of material. The arrangement is systematic and progressive. The raw



Insulating a Single Coil for an Air Blast Transformer

Weighing a Large Casting

material or rough casting enters a department at one end and passing through successive stages of manufacture is carried steadily forward to final assembly and test. The completed machine is prepared for shipment in the department in which it is constructed, the large apparatus being there mounted upon the railway cars. For this purpose tracks of standard gauge enter every aisle and a number traverse the entire building.

Railway Motor Department

A more detailed consideration of one section will illustrate the systematic progress of the work to which reference has just been made. To section A, in which railway motors are constructed, are delivered the rough castings for the frames, armature spiders and gear cases; rough forgings for the axles; sheet iron punchings for the laminated cores; finished commutators; finished brush holders; and completed armature and field coils. The rough forgings, castings for the spiders and iron punchings are received at the south end of the section; the shafts and spiders machined; the laminated cores are built up upon shaft or spider, according to the size and design of the armature; the slots are made true, and the finished cores are delivered to the winding department where the coils are put in place. The commutator is next mounted, the coils connected and the armature completed. As the work progresses step by step it gradually advances up the aisle toward the assembling and testing department in the center of the section. At every stage of its progress it is subjected to the close inspection of experts trained for this particular duty and each and every part tested during construction and when complete.

Simultaneously with the processes just described the rough castings for the frames and gear cases are received at the northern end of the section and, passing through the milling, boring and drilling machines, are gradually worked down the aisle to meet the completed

Winding Street Railway Motor Armatures, Section A

armatures in the assembling department, where field coils, brush holders and bearings are mounted in place, the armature inserted and the completed motor turned over to the testing experts and thoroughly tried out for temperature rise, insulation strength, speed regulation and general operating characteristics. As with the armature, so with the field, each stage of manufacture is carried on under the eye of trained inspectors and each part subjected to repeated tests during construction.

After test the completed motor is painted and prepared for shipment and transferred across the shops over the tracks of an industrial railway operated by small electric locomotives, and delivered to the warehouse just east of Section D.

Other Sections

Storerooms are provided in each department for the material in immediate demand, supplied from the general storehouse to which all material is delivered and in which it is held till drawn out to fill a particular shop or manufacturing order. Many of the tools in this, as in all departments of the works, are specially designed

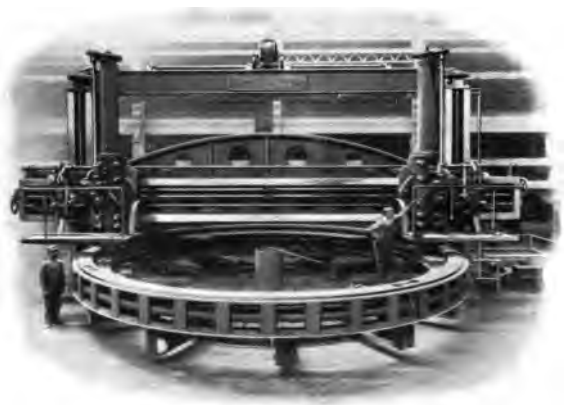
for particular operations. Multiple spindle drills cut all parallel holes in the casting in one operation. Motor fields and bearings are bored out together thus insuring absolute alignment. Some machines bore two motors at the same time. Several castings are mounted together on one machine and milled off or planed true simultaneously. Everything possible is provided to reduce labor, minimize handling and insure accuracy and the exact duplication of parts. In all this work electric cranes play an important part. They traverse the entire section and expedite nearly every process.

In section C, which is devoted to the production of smaller machines other than railway motors, the various manufacturing processes are much the same as those just described, but in sections B and D where large apparatus is constructed there is, of necessity, more variety and less duplication of operations. The same systematic progession of the work is maintained here, though the testing departments are located near one

Main Aisle, Section B

end of the aisles. As the large machines are not delivered to the warehouse but are loaded on the railway cars within the section, it is here literally true that the raw material enters one end of the building and the finished product is shipped out at the other. The thirty-ton traveling cranes in section B and the fifty-ton cranes in section D make the handling of heavy material a matter of simple routine.

In section D have been constructed the largest generators in the world, the dynamos now operating the elevated and underground railway systems in New York City. During their manufacture a method of procedure



Turning Down Field Spider for 5000 KW Generator

new to machine shop practice was devised and the transit introduced as a means of setting work and tool in true alignment. The piece to be machined was mounted and set true on the surface bed plate. A center column was next located in exact relation to the work by the use of a centering gauge and secured to the floor plate where it remained throughout all the operations on a particular piece of work. On this center column the dividing instrument, which is of somewhat special con-

struction, was mounted and the correct position of the zero divison of the dividing circle determined by means of the telescope. Straight edges were then secured in such positions that their front edges were in exact alignment with what were to be the finished surfaces, their precise location being found by use of the dividing instrument. By means of these straight edges and the dividing instrument the portable tools necessary for the various operations of slotting, planing, drilling, etc., were mounted in exact position on the floor plate.

The accuracy of the method is illustrated by the fact that the variation in the alignment of the vertical joints of the eight generators constructed for the Manhattan Elevated Railway did not exceed three hundredths of an inch. The frames of these machines measure over forty-two feet in height and consist of six parts. A complete generator, without shaft, weighs over one million pounds.

Many of the tools in this department are portable, each driven by its individual motor and connected to the distribution system by flexible cable. In many cases a heavy casting is mounted on the floor and the tool brought to the work, reversing the usual procedure of mounting the work on the tool. Frequently two or more tools are busy on a casting at the same time, cutting slots, drilling, or whatever the work may be.

The 5,000 K W generators just mentioned are still remarkable for their mechanical size, but they will soon be surpassed in capacity, for turbine type alternators of double their rated output are now under construction and will shortly be placed in service. As the output of the unit increases approximately as the total output of the works, a record for bigness is held but a short time by any individual machine.

The winding department is located in one of the galleries. Here are prepared the form wound coils for generators and motor fields and armatures of all types, together with coils for transformers, instruments and

other apparatus, large and small. This section also includes the insulating department in which mica and other material is prepared and applied to the finished coils. Much of the winding and insulating is performed by girls who are found particularly deft and skillful in work of this character not too heavy for their strength.

This department has its own shop where the forms or molds are made, on which the coils are shaped.

The remaining space in the galleries of the main shop is devoted to the manufacture of small transformers, brush holders, commutators, controllers, automobile motors and other detail apparatus. Each department has its own testing room and corps of inspectors and every finished product is prepared for shipment in the department in which it is constructed.

The warehouse building adjoins and parallels section D from which it is separated by a heavy fire wall. The warerooms occupy two floors but do not extend the entire length of the building, the southern extremity of which forms the power-house from which current is delivered to the workshop just described. The second floor of the warehouse is now devoted to the manufacture of switchboards, rheostats, starting boxes, railway diverters and like apparatus, but these departments are

One of the Drawing Offices

5000 KW Generator in Course of Construction

soon to be transferred to the new building recently completed.

The several departments thus far considered are all under one unbroken expanse of roof in a single building measuring, approximately, 1,200 feet in length by 373 feet in width and containing a floor space of 800,000 square feet.

Immediately south of the warehouse building and across a short intervening yard, which is traversed by an overhead crane, is the Punch Shop in which are prepared the sheet steel laminæ so largely used in the construction of electrical apparatus. The steel sheets are here received, annealed and treated by processes known only to the company's iron experts and punched under heavy presses into the many forms required for the various products of the works. The building is a two-story structure and measures 418 x 76 feet.

South of the main machine shop, located in separate buildings, are the Brass Foundry, 418 x 76 feet; the Blacksmith Shop, 243 x 83 feet; the Oil House, 89 x 21

feet, and the Sheet Steel Storage Building, 368 x 41 feet. Across the rear of these buildings and overlapping the new East Shop there extends a large crane shed used as a receiving and storage department for castings and other heavy material. This building measures 603 x 213 feet.

The Carpenter Shop, an irregular building with a floor space of 39,360 square feet, is located behind and to the left of the crane shed.

The Standard House and Record Vault are across the street west of the main building.

The East Shop

The new East Shop is completed and is now being equipped. It will relieve the congestion in many departments of the older works and increase the productive capacity of the company over fifty per cent.

The new shop is entirely under one roof and is said to be the largest single building in the world wholly devoted to manufacturing purposes. Its total length is 1,658 feet, nearly one-third of a mile. In general

A Working Corner in the Standard House

form it is similar to the older shops, and consists of a high central bay flanked on either side by aisles which have both ground and gallery floors. The central section extends the entire length of the building and is without obstruction other than a drawbridge which connects the two gallery floors and which may be raised or opened to let a crane pass with its load. This drawbridge is thirty-three feet wide and seventy feet in length, that being the width of the central bay. The new building contains a total floor space of nearly 700,000 square feet, most of which is directly available for manufacturing purposes.

Seven bridges of various widths from sixteen to sixty-four feet connect the East Shop to the older buildings. Five of these bridges are on a level with the gallery floor and allow the passage underneath of interworks and freight trains. The other two are over the power houses.

In the arrangement of departments economy in manufacture and a minimum transportation of material have been the two chief items of consideration. The lines of manufacture for the five new sections are, in general, as follows:

The Industrial Railway

Section P, running south from the power-house, as indicated in the diagram on another page, is utilized for the development and manufacture of transformers of all sizes and types, static interrupters and such apparatus. The transformer testing department occupies the entire width of the section for a distance of 192 feet, immediately south of the power-house wall, enclosed on all sides by fire walls with arched ceilings, and is, therefore, as nearly fireproof as possible. Within this department a space has been alloted for experimental determinations, including a reservation, enclosed within partition walls extending from floor to ceiling, for tests on detail apparatus designed for high tension service.

Between the east wall of the boiler room and power-house, separating them from section R, provision has been made for the erection of twelve towers arranged for the treatment of insulating material by a continuous process.

The portion of section P south of the power-house will be occupied by the tinning, pole piece and cutting off departments, the last named being a new division in which it is proposed to cut cold rolled steel, axle steel and tool steel for all departments of the works requiring material of this character.

The high central bay of the new building will be equipped for the production of alternating and direct current dynamos and motors, rotary converters and other apparatus, with the exception of street railway motors, having rotor and stator elements, of capacity 100 HP up to and including machines having a maximum internal bore not exceeding six feet. This will relieve the main aisles of the older shop of the smaller apparatus and leave them free for the larger work, to which their equipment is especially adapted. By making a definite diameter of maximum bore of the stationary part the dividing line between departments, the maximum size of the machine tool equipment of the new section was immediately determined.

I. 1,000 KW 3,000 Alternation Turbo-Generators
II. Single Shipment of 21 Cars Loaded with Westinghouse Product
III. Engineering Apprentices in Dynamo Testing Department

The remaining aisle on the ground floor of the East Shop differs from other departments in the main shops in that but little of its product will be completely assembled within its limits, its chief function being the supply of parts to other sections. Its space will be divided among six newly organized departments known by the names of Frame, Bracket, Spider, Building, Shaft and Bearing, the name signifying the character of the work performed in each.

On the gallery floors in the East Shop, switchboards, instruments, detail apparatus and small tools are constructed. A model department has been established devoted exclusively to the development of the smaller types of apparatus, which have passed the experimental stage, and the production of manufacturing models which can be used to prepare special tools, fixtures and gauges for the economical manufacture of constituent parts. Every section is abundantly equipped with electric cranes, twenty of which have so far been installed in the new building.

Transportation of Material

In so large an establishment the transportation of material presents problems of great difficulty. The facilities provided for this purpose in the Westinghouse Works are abundant and complete. In addition to the overhead cranes and standard gauge tracks, to which references have been made, a complete industrial railway system traverses the entire works, connecting the several sections and departments. The industrial trains are drawn by small electric storage battery locomotives and are run on regular schedules which are carefully maintained.

The principal route of material transportation between the old and new buildings is a tunnel connecting sections C and S and equipped with double industrial railway track and elevators at the terminals.

Current for various testing purposes, lighting of the

buildings and operation of the tools, cranes, elevators, etc., throughout the works, which are all motor driven, is supplied from two power-houses, one located in the southern end of the warehouse building and the other along side the first but within the walls of the new East Shop. The equipment includes thirty 250 HP Babcock & Wilcox water tube boilers, six 500 HP Westinghouse Compound engines coupled to 375 KW, two-phase, 220-volt generators, two similar engines coupled to 375 KW 500-volt direct-current generators, one 600 HP Westinghouse vertical gas engine coupled to a 400 KW, 500-volt direct-current generator and two Westinghouse-Parsons steam turbines direct connected to 1,000 KW, two-phase, 220-volt alternators of the turbine type, together with rotary converters, transformers, steam and motor driven exciters, switchboards, feed water heaters, automatic stokers, coal and ash handling mechanism and other apparatus necessary to a complete and modern electric generating station. Coal, unloaded from the cars, passes through crushers to conveyers which carry it to the storage bins from which it is supplied to hoppers in the boiler rooms and fed to Roney mechanical stokers under the boilers. The conveyers are so arranged that coal may be delivered to the hoppers direct from the crushers without going to the storage bins.

Power and Equipment

The Westinghouse Company has been for many years a consistent advocate of the motor driving of machine tools and other apparatus in a manufacturing plant. Data in this connection gained from outside sources and the equipment of other factories have been fortified by the company's own experience as a manufacturer. The entire works are motor driven on the two-phase 3,000 alternation system, excepting the cranes in the earlier buildings which are equipped with direct current motors. Not including cranes there are

now in service throughout the shops nearly 250 motors with an aggregate rated capacity of over 5,500 HP.

The cranes in the later buildings are operated by alternating current motors of the induction type. The works contain in all some sixty odd overhead traveling cranes ranging in capacity from three to fifty tons. Many of the larger cranes are equipped with auxiliary hoists for lighter service.

The whole mechanical equipment is of the very best and is complete in every detail. Rapid duplication is made possible by the use of jigs and other mechanical aids to quick and accurate workmanship.

The buildings are well lighted, heated and ventilated throughout. Daylight is admitted through windows, which occupy seventy per cent of the total outside wall area, and through skylights in the roof. Numerous arc and incandescent lamps furnish light during the dark hours. Some of the sections are illuminated by the new Bremer arc lamps and Nernst lamps are quite generally used in the offices while one of the draughting rooms is lighted with Cooper-Hewitt mercury vapor lamps, found particularly desirable in such a service.

Heat and ventilation are supplied by an indirect system. Fresh air propelled by motor driven fans is distributed through the buildings by means of pipes of large diameter with outlets every few feet. In cool weather this air is heated by passage over coils supplied with steam from the engine exhaust, or, if necessary, direct from the boilers in the power-house. The shops are at all times maintained comfortable whether the outside temperature be high or low.

Scattered through the buildings, for the most part on mezzanine floors underneath the galleries, coat and toilet rooms are provided in which each operative has a locker. The toilet rooms are models of convenience and good sanitation, and are kept scrupulously clean. Every possible provision is made for the health, welfare and comfort of the employees. Clean towels and soap are provided in abundance. Drinking water sup-

Railway Motors Ready for Shipment

plied from artesian wells is piped through all the buildings with running fountains located at convenient points but a few feet apart, so that every worker finds an abundant supply of clear, cool water always at hand.

Offices

The six-story building which stands immediately in front of the main machine shop provides a floor space of over 90,000 square feet for office purposes and when constructed was sufficient for the accommodation of the executive, sales, treasury, legal, engineering and operating departments with their corps of assistants, draughtsmen and clerks. The great increase in business has, however, necessitated additional facilities which have been provided in the new building, the entire front of the East Shop being set apart and furnished for office purposes.

Systems of Communication

Communication between the various offices and departments is facilitated by private telephone and pneu-

matic mailing systems supplemented by a messenger service. The telephone equipment is very complete, with a central of its own and switchboard arranged for 600 numbers, two-thirds of which are in daily use. The long distance telephone switchboard, located in the same office, is provided with seventy-five drops, sixty of which are in service. The local telephone circuits are operated on the Stromberg-Carlson Central Energy System.

The pneumatic mailing system supplies thirteen stations located at convenient distributing points. Each station is connected to the Pneumatic Central, an illustration of which is shown on this page, by a 2½ inch tube. The longest line measures 1,550 feet and is said to be the longest pneumatic service of the kind ever attempted in this country. Letters, sketches, small drawings and prints are easily transmitted through these tubes. More bulky mail is delivered by messenger.

The company also maintains a private telegraph line between East Pittsburg and its offices in New York.

Products

The output of the Westinghouse works includes practically every form of electrical apparatus required in

Pneumatic Tube Central

Main Office Building, Westinghouse Electric & Mfg. Co.

lighting, railway and power service. The many styles, types and sizes run up well into the thousands. Few manufactories turn out so varied a product. The enormous proportion of the work is indicated by the average daily production of generators and motors alone which reaches an aggregate capacity of over 5,000 KW. Such results necessitate a large and thoroughly equipped plant and a thorough, united and resourceful organization; more especially as the manufactured product is not only greatly varied but is also subject to rapid change of form and type. Standardization has been carried far, but new devices, modified forms and improved construction are still constantly introduced to a ready market quick to appreciate advance and improve-

Assembly Hall, Electric Club

ment and accustomed to find the latest and the best under a Westinghouse nameplate.

Among the more recent notable achievements of this company in the line of new and improved apparatus may be mentioned the single-phase railway motor, the unit switch system of multiple control, the turbine type generator, the static interrupter, the M. P. lightning arrester, the type A wattmeter, the new arc lamps, both series and multiple, and the series arc regulator for alternating current circuits.

Working Force

The rapid development of new and the modification of older apparatus adds greatly to the difficulties of the manufacturer and necessitates an organization of flexibility and power, including an enthusiastic, loyal and well-trained working force. Without such a force a modern equipment is of little avail. A good tool can

accomplish little in the hands of a skilless artisan. With highly developed system and facilities there must be joined a highly developed force of men, thoroughly disciplined and skillfully led.

In few industrial establishments can there be found so hearty a spirit of co-operation and so kindly a feeling between fellow workers and so loyal a devotion to the company and its interests as are characteristic of this "Westinghouse family," as it is often called. All are parts of one grand organization in which each takes pride and for which each worker feels a personal responsibility. Fair and generous treatment is accorded to all and full credit granted for every merit made evident by work. Every facility is provided and every employee encouraged to develope the best there is in him.

Wage System

In the payment of employees the company follows an enlightened policy by which the operative profits by putting forth his best endeavor. Wherever possible the Premium System is applied, based on a fixed time for the performance of a given operation with a substantial reward to the workman, in addition to the regular hourly wage, proportionate to the time saved. If, on the other hand, the time taken for a given operation exceed the time limit fixed, the employee is paid for his actual working time at his regular hourly rate, so he always makes the full time value of his working hours and may in addition gain a premium by working more rapidly. That the system may be effective and carried on in good faith a promise is made that a time limit once fixed will not be altered unless justified by a substantial change in the method of manufacture.

The Premium System, while of advantage to the employees in that it enables a good workman to earn a high hourly wage, is also of advantage to the company as it brings an increased return per unit of time

and equipment. It is eminently fair to both sides and has been proved a decided success. It brings out the best efforts of the operative who works in confidence that extra endeavor will bring additional reward, it urges him to originality and improved methods and fosters a commendable spirit of friendly interest and co-operation.

In works of so large a size and with so varied a product there are, of course, operations to which the Premium System cannot readily be applied. With such other methods are followed. The Premium System, however, governs the great majority of operations in the works of this company. It seems to be acceptable alike to the management and the men employed.

Production Department

It is not sufficient that an order be entered and the work of manufacture be skillfully performed. Contracts usually require that apparatus be completed at a specified time. With the multitude of orders passing through the works systematic attention is required that each shall progress towards completion at the allotted time. The quantity of work must be kept up to the point necessary to meet the orders in hand. This responsibility lies at the door of the Production Department which is composed of a force of trained clerks under a Superintendent of Production, whose duty it is to keep track of the progress made from day to day on each order in the works, to prevent delays and conflicts, and to see that each and every piece of apparatus sold is ready for shipment at the time promised.

A portion of the staff of this department is stationed in the shops to follow the work on the floor. The remainder is utilized to keep track of the orders, each man looking after apparatus of a certain kind or size and watching the various component parts, wherever manufactured, so that all may come through together and the order be completed at the proper time.

I. Reading Room, Electric Club
II. East Pittsburg Club House

Employment and Attendance

That accurate record may be kept of the attendance of the working force each employee is given a small brass check marked with the company's name, the workman's number and the designation of the section to which he is assigned. On entering the buildings in the morning the check is shown to the watchman as evidence of the right to enter. On arrival at his department the employee hangs the check upon the check-board which is located near the foreman's desk, on the hook corresponding to his check number. At the close of work the checks are taken down as the employees pass out. They therefore serve to keep the time and also as passes to and from the works. The system is simple but very effective, accurate though almost automatic in its action.

The greatest care is taken in the selection of new employees. This work is entrusted to a special department known as the Employment Department, under the direction of a skilled mechanic, whose duty it is to personally interview and pass on each applicant for position. The company believes that it is better to make a

Employees Leaving Works

I. Private Dining Room, Office Building
II. Corner in Office
III. Dining Hall, Casino

thorough examination at the start rather than learn by trial that an applicant is not qualified to perform the services for which he is employed. Foremen of the departments are consulted but the final selection of new men lies with the Employment Department and on it the responsibility rests.

Whenever a workman is engaged, an employee's certificate is made out recording the name, birthplace and age of the applicant, his previous experience, and such other information as may be obtained. On this certificate is also kept the history of the employee as long as he remains with the company, showing transfers from one department to another and other data of value as a determination of individual efficiency and faithfulness. If for any reason it becomes necessary to reduce the force in any one department the employment bureau is notified and effort is made to place the operative in other portions of the works.

Apprentice System

As the future strength of a community is in its young men, so the development of an efficient working force depends in a large measure upon its apprentice system. This company has had in force since 1896 a carefully

One of the Drinking Fountains

arranged system which provides for two classes of apprentices, those without preliminary technical training, called Ordinary Apprentices, and those who are graduates of technical schools, called Engineering Apprentices.

For the first class a course of four years is provided with pay ranging from five to fifteen cents per hour, according to length of service. During this time the apprentice learns thoroughly that particular branch of the work for which he seems to be best adapted and becomes in the end a skilled mechanic, or, if of exceptional ability, an inspector or foreman.

The Engineering Apprentices, each of whom has already received a technical degree from some college or university of standing, serve through a two years' course with pay running from sixteen to eighteen cents per hour. They are given a wide range of work enabling them to get an insight into all branches and methods of manufacture, serve for a time in the draughting room and on the testing floor and, as far as possible, are made acquainted with the business methods of the company. In this way a body of trained men is developed from which are drawn engineers, designers, constructors, salesmen and men for almost all positions

A Few Engineering Apprentices

of responsibility at the company's disposal. At the present time there are about 200 such apprentices in the works. That the training is of value and appreciated is evidenced by the number of applications for entrance to the course. The waiting list contains the names of many graduates of our universities and colleges who are anxious for the opportunity to enter practical engineering in so favorable a way.

Educational and Social Features

The company believes that it is good business policy to promote the educational and social advancement of its employees and has found that effort in this direction is fully justified by results. Chief among the agencies established to this end is the Electric Club, an organization of 500 members gathered from the office, engineering and apprentice forces of all the Westinghouse Companies in the vicinity. The home of the club is adequately equipped with library, containing the more important technical journals, class rooms and assembly hall with seating capacity of nearly 300. The object of the organization is both educational and social. Lectures and discussions, elementary and advanced, for the consideration of electrical and general engineering subjects are held nearly every evening. These meetings are usually under the leadership of engineers from the regular engineering staff of the company. From time to time non-technical lectures are also given by prominent men within and without the company's organization. The local branch of the American Institute of Electrical Engineers holds its monthly meetings in the rooms of the club and these meetings are open to club members. The cost of membership is small. Every two weeks entertainment of a social nature is provided under the guidance of a committee of ladies, chosen from among the wives of the company's engineers and officials. The apprentice system draws men from all over the world who are, of

necessity, living away from home. It is the endeavor, in so far as possible, to promote a wholesome enjoyment of life amid pleasant and refining influences. The attendance at these entertainments and the work done in the lecture room indicate a thorough appreciation of the club's advantages. It plays a prominent and useful part in the life and training of the growing engineer.

The club maintains a monthly illustrated magazine, the Electric Club Journal, for the immediate purpose of putting into permanent form the engineering papers and technical discussions which form a regular part of its activity. This Journal is unique in that it is prepared precisely and definitely for the young electrical engineer, by men close to him who appreciate his qualifications and his need, and under the guidance of engineers of experience and world-wide reputation who are in daily touch with the advanced engineering practice of the day. Though but a few months old the Journal already ranks high among technical magazines.

For the shop forces and those desiring more elementary instruction, a Casino has been erected near the works and classes established under a corps of six instructors. The average attendance at these classes is now over 100. The courses are divided into two terms of about five months each, twelve hours per week. They embrace the elements of mathematics, English, technical science and shop practice. The cost to the student is but two dollars per month. The classes are filled with men anxious to learn and alive to the practical value of technical instruction.

The Casino building also contains bowling alleys, billiard tables and lunch rooms, all of which are well attended during non-working hours.

To the management of the company it has not seemed wise to enter directly into general beneficial or pension organizations, but it has been thought better that such matters should be handled by the employees themselves through properly conducted and liberally assisted associations. Among such organizations may be mentioned

Inter-Works Line connecting various Works at East Pittsburg, Wilmerding and Trafford City

the "Westinghouse Electric and Manufacturing Company's Beneficial Association," and the "Foremen's Association." The former is open to any employee of the works and, on the payment of a small initiation fee and a monthly due of fifty cents, guarantees a weekly indemnity of five dollars per week for disability and a death benefit of two hundred dollars, one-half of the latter being paid by the company. This association numbers about 1,100 members.

The Foremen's Association has between 200 and 300 members drawn from among the foremen, inspectors and chief clerks in the various departments of the works. Its objects are both beneficial and social.

On the theory that close acquaintance leads to better understanding and more cordial co-operation, the company maintains two beautifully furnished dining rooms on the sixth floor of the Office Building where the executive officers, managers and representatives of each department daily gather at the noon hour for a substantial lunch and a free interchange of ideas all the more effective because it is unofficial. These dining-rooms have done much to promote the harmony and

kindly spirit of helpfulness so characteristic of this organization.

The East Pittsburg Club is conducted by the company to provide suitable dining quarters for its large engineering and commercial staff. Comfortable lunch and rest rooms are also provided for the women connected with the various offices.

The foregoing description has attempted only to give an outline of a great organization, a glimpse at the life of a giant industry. Modern methods, tireless activity, systematic effort, a happy and contented force, wise and fearless leadership, are here found at their best. The works and the organization but reflect the qualities of the man that made them, whose name they bear — "By their fruits ye shall know them."

Employees Waiting for Home Train

An Epoch Making Experiment

THE following account of the "Lawrenceville Test" is taken from an article by Mr. Lewis Buckley Stillwell, Electrical Director, the Interborough Rapid Transit Co. of New York, entitled "The Development of Electric Power Transmission," appearing in Cassier's Magazine for June.

"In October, 1886, in a small room on the top floor of an old house in Pittsburg, Pa., three hundred incandescent lamps were lighted continuously for a period of about two weeks by alternating current, transmitted a distance slightly exceeding two miles, over a single-phase circuit, comprising two copper wires of No. 4 B. & S. gauge. The potential used was 1,000 volts, the frequency about 130 cycles per second, and the lamps were connected in parallel to the secondary circuits of half a dozen transformers. The ratio of transformation was 1,000 to 50.

"This was the first instance, in America at least, in which alternating current was used in transmitting electric energy beyond laboratory distances for the supply of translating devices connected in multiple arc. The alternator used to supply the power was driven by belt from a line shaft, to which a high-speed automatic engine was connected, and this generating plant was located in a shop of the Westinghouse Electric & Manufacturing Company on the banks of the Allegheny river within a mile of the site of old Fort Duquesne.

"It was the writer's fortune to be detailed to watch those lamps during twelve hours out of every twenty-four during the test — his first practical experience in

applied electricity — and he vividly recalls the keen interest with which everybody who had anything to do with the work observed the results. In the history of American industrial progress the Lawrenceville test, as it has been called, was an event of no little importance. To Stanley and Shallenberger, for the technical skill and for the patient work which produced the apparatus, and to George Westinghouse, whose far-sighted enterprise realized possibilities at that time scouted by others, all those who now are deriving benefit from the wonderfully extended use of alternating currents are under an obligation which they should gladly recognize.

"Prior to the Lawrenceville test, distribution of electric energy to lamps or motors had been accomplished by continuous-current systems operating at potentials of 110 to 220 volts. The three-wire system invented by Edison, permitting the use of a potential of 220 volts, was coming into use for general purposes in the larger cities, and was regarded as the highest potential available for such work. The general significance of the results of the Lawrenceville test was keenly realized; but the difficulties encountered in attempting to develop single-phase, alternating-current motors, capable of operation at the high frequency then used, practically prevented for a number of years the use of alternating current for power purposes. It was, however, rapidly developed and extensively applied in the field of incandescent lighting.

"Tesla patented the polyphase alternating-current motor in 1888, but this also was slow in development, owing largely to the fact that for a long time in America efforts were principally directed toward the development of a motor adapted to the high frequency of 130 cycles per second. In 1890 the Westinghouse Company adopted as standards two lower frequencies — 60 cycles per second and 30 cycles per second. The step facilitated greatly the development of satisfactory polyphase motors, and not long afterward they began to come into commercial use.

"The commercial significance of the Lawrenceville test is strikingly illustrated — although the impression conveyed by the illustration is a somewhat exaggerated one — by the story of the manager of the gold mine in Colorado, who, in 1896, was able to operate a stamp mill located at a distance of about three miles from his water-power by alternating current transmitted to the motor over a circuit consisting of iron telephone wire of ordinary size. This was accomplished by using a high-potential single-phase alternating current. The cost of the telephone wire was about $60. It is stated that an estimate for a continuous-current plant to do the same work had been submitted by a manufacturer of continuous-current machinery, and that these plans called for the installation of copper circuits costing more than $60,000."

* * * * * * * *

"To my mind, the most important events in connection with the evolution of electric transmission in America are: (1) The Lawrenceville test of 1886, by which the commercial practicability of the constant-potential transformer — the key to high-potential transmission — was demonstrated; (2) the invention of the polyphase motor, patented by Nikola Tesla in 1888; and (3) the adoption, in 1893, of the polyphase alternating-current, constant potential system as the means of distributing power from Niagara Falls.

"The Lawrenceville test demonstrated the possibilities of the transformer in reducing the cost of transmitting circuits, the invention of the polyphase motor furnished the means of utilizing the transmitted power for power purposes, and the adoption of polyphase alternating currents by the Cataract Construction Company for the great work at Niagara Falls sealed the commercial success of the system. An excellent meter for alternating currents had been invented and perfected by Shallenberger as early as 1888, and Elihu Thomson also had produced an effective meter for the same kind of service."

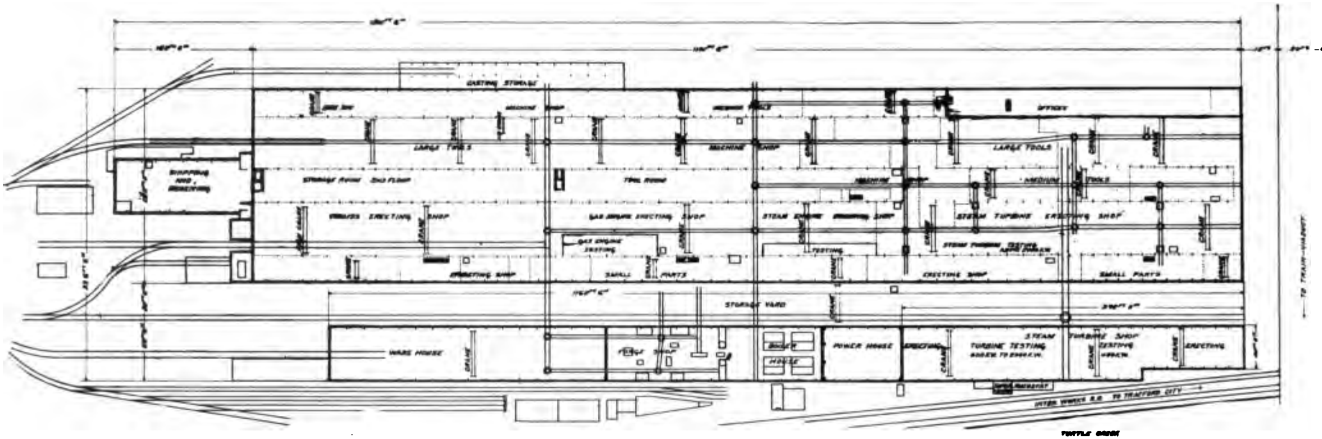
Bird's Eye View—Westinghouse Machine Co.
Works of Westinghouse Electric & Mfg. Co. in Background

Westinghouse Machine Co.

IF THE prime interest of the electrical engineer in inspecting the industrial development of Pittsburg centers in the manufacture of electrical machinery and appliances, he, nevertheless, soon directs his attention to machinery adapted to the furnishing of the propulsive force; in other words, the prime mover. At East Pittsburg he is fortunate in the opportunity of observing, in their proper relationship, the construction and operation of prime mover, generator, controlling and translating device in the most recent state of development of their respective arts.

The manufacturing operations of The Westinghouse Machine Company are primarily devoted to the production of different forms of prime movers, although an important branch of their business is the manufacture of mechanical stokers. The combined properties of the company comprise the main works at East Pittsburg, Pa., the stoker works at Cragin (South Chicago), Ill., and the recently established foundries at Trafford City, Pa., located about three miles east of East Pittsburg near the Stewart station of the Pennsylvania R. R. main line.

In the main works at East Pittsburg may be seen in all stages of completion steam engines from 5 HP to 6,500 HP, gas engines of small capacity as well as of the heavy duty double-acting type, and steam turbines from 500 HP to 7,500 HP capacity. The turbines form a particularly striking exhibit in having attained, within so recent years, the most prominent position among modern prime movers.



GROUND FLOOR PLAN OF WORKS, WESTINGHOUSE MACHINE CO., EAST PITTSBURG

The accompanying view clearly shows the position of the main works, convenient to the Pennsylvania R.R. station and nestled in among wooded hills surrounding the beautiful valley of Turtle Creek. Although Nature's best efforts in contributing to the earthly comfort of man have here been partly nullified by the inevitable concomitants of industrial activity, there still remains a romantic beauty invariably commented upon by every newcomer.

In general appointment, the works of The Westinghouse Machine Company bear a close resemblance to that of its affiliated neighbor, the Westinghouse Electric & Manufacturing Company, and thus the features of the latter, previously described, may, to a large degree, be considered representative.

The engineering and administrative offices are at present located in the works proper, pending the erection of an office building. Lunch rooms are maintained for the entire official and engineering force, and numerous lavatories and lockers are available to shop men.

In the foundry establishment at Trafford City, the sociological features have been given even closer attention, due to its comparative isolation. A new and thriving industrial city has been established upon the most modern lines, and a capacious club house erected for the convenience and comfort of the executive force.

The general arrangement of the East Pittsburg works, as shown in the accompanying plan, is that which has become characteristic of Westinghouse works — the arrangement of principal buildings in long parallel bays, each served by numerous electric traveling cranes at one or more elevations, according to the height of work handled. In order to supplement the crane service with means for shifting work from bay to bay or to adjacent buildings, The Westinghouse Machine Company has developed a system of storage battery auto trucks of from ten to fifty tons capacity.

The entire works, including cranes, is electrically driven by 220-volt polyphase current (excepting a

few variable speed D.C. motor applications) from a central power station comprising about 1,500 HP in gas engines operating upon natural gas, and 1,000 HP in steam engines taking steam from an adjacent central boiler plant which also supplies steam hammers, steam for turbine and engine testing and for heating purposes. In the equipment of the shop, individual motor drives have been largely employed (e. g., 125 in. x 30 ft. engine lathe) with group driving for the smaller tools. Floor plates with portable electric driven tools are also used.

A feature of striking interest, in which The Westinghouse Machine Company practically stands alone, is the complete testing equipments for steam engines, gas engines and steam turbines. Before shipment, every prime mover from a 5 HP stoker engine to a 7,500 HP steam turbine is subjected to complete efficiency tests under ultimate conditions of service. Gas engines are tested on natural or producer gas, according to their design; steam engines under varying pressures and vacua; and steam turbines under guaranteed conditions of steam pressure, vacuum and superheat; all meas-

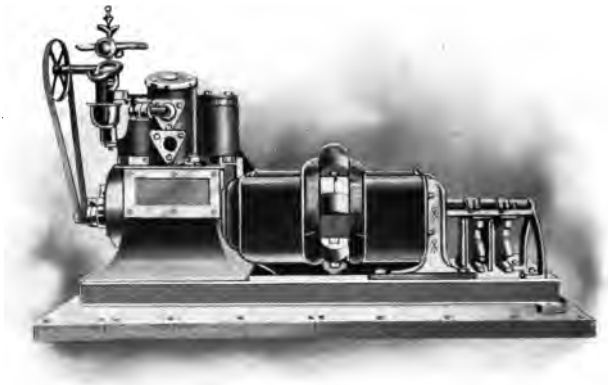
Testing Westinghouse-Parsons Steam Turbines

Erecting 7,500 HP Steam Turbine

urements being based upon brake horsepower, electrical horse power, or kilowatts. In the turbine erecting shop, separate testing floors are equipped for machines of 400 KW capacity, and from 750 up to 2,000 KW capacity respectively, and, in the main building, for turbines up to 5,500 KW capacity, this probably being the largest equipment in the world employed solely for testing purposes.

The Trafford City foundry is likewise operated by polyphase motor drive from a central power station, and may be considered in every detail one of the most completely equipped foundries in America. Its pattern storage has at present sufficient capacity to accommodate 50,000 patterns of all sizes, and castings up to 60 tons in weight may be handled with the present equipment.

Since its organization in 1881 with a working force of 10 men, The Westinghouse Machine Company has grown to such an extent that 3,500 men are now employed, and the properties at present aggregate nearly 50 acres with a total working floor area of 20.4 acres. The output, exclusive of mechanical stokers, has consisted entirely of prime movers, and the growth of business is well indicated by the present rate of output, viz:



The Original Westinghouse Single Acting Engine Unit

150,000 HP per year; little less than 200 times the original annual output.

The industrial growth of The Westinghouse Machine Company from the date of its first engagement in manufacturing undertakings may be considered to be contemporaneous with and typical of the development of modern prime movers. A brief glance into its history is, therefore, instructive, not only in throwing light upon the successive steps of progress in American engine practice, but also to enable us to form a more accurate conception of the measure of advancement which has been recorded.

In 1880, a single-acting, high speed, self-contained steam engine was introduced into a field almost exclusively devoted to slow or moderate speed double-acting engines. This diminutive engine, illustrated above, found its first application in driving a small Brush arc generator supplying a locomotive headlight. The design of the engine was in a large measure the result of

conditions imposed by the special and difficult character of service; and it is now with renewed interest that, in retracing the steps of progress, we find embodied in this embryonic motor many of the most heartily approved principles of modern power engineering, viz:

The direct connection of engine and generator;
Vertical design;
Non-reversible stresses;
High speed;
Self-contained construction;
Automatic lubrication;
The use of high steam pressure.

At the outset, the necessity for interior compactness prescribed the vertical construction and replacement of the then universal belt transmission by direct connection with an outboard bearing to support the generator shaft. And, as the engine was obliged to meet the generator speed — 1,000 RPM — the single-acting de-

Assembling 7,500 HP Turbines for Testing

sign was adopted, through which an important advantage was realized in preventing the reversal of mechanical stresses resulting from the pressure of steam and inertia of moving parts. Thus, the sensitiveness to adjustment characteristic of the double-acting engine was, to a large degree, avoided. Although the return to the double-acting principle was later necessitated through the demand for larger powers, the single-acting principle, modified, to be sure, from reciprocating to rotary motion, now finds its latest exponent in that nearest approximation to the ideal motor, the Steam Turbine. Accompanying the increase in running speeds came a proportional decrease in size and cost of machinery, with the result that 10 electrical HP may now be generated upon one square foot of floor area.

Up to the present time, vertical design has been typical of the most compact engine construction, but the advent of the turbine brought out the fact that, until a corresponding compactness could be secured in steam generating apparatus, the horizontal design with its economic and operative advantages might well be retained.

The enclosed construction of the original engine was necessary to protect the internal moving parts from dust and from general ill-usage. Incidentally, the advantages of automatic splash lubrication became possible and the system has since been adopted by many builders.

Again, we have a direct parallel in the modern turbine, although the enclosed construction is here functional rather than fortuitous. A long step in advance has, however, been made; internal lubrication has been entirely dispensed with and that necessary at the journals is automatically supplied by the turbine itself.

Finally, the steam pressure for which the original Westinghouse engine was designed was 150 to 180 pounds, this condition being prescribed by its adaptation to steam supply from the locomotive. In the

80's, the prevalent steam pressures for power work were 60 to 80 pounds with a maximum of 100. Owing, in a large degree, to the introduction of water tube boilers, the average steam pressure, during the intervening years, has gradually risen to 125 pounds in engine work with a maximum of perhaps 175 pounds. The influence of the steam turbine, however, has already been felt in the general advance of steam pressures to an average of 165 pounds with a maximum of about 200.

The underlying principle of early Westinghouse practice was that of subdivided power, at that time quite unappreciated. Applied to mill work and power stations, greater operative economy and convenience were found to be realized, and to-day, by virtue of its fitness, the principle dominates industrial work through the medium of the polyphase motor and power station design, from absolute necessity. The step from 100 HP to 10,000 HP units has been accomplished within twenty years, yet power stations now contain perhaps ten and ultimately twenty units of 5,000 to 10,000 HP capacity.

Returning to the development of the Westinghouse engines, of which the engine above referred to was the forerunner, we observe step by step the gradual advancement in product embodying in succession the Standard engine, the Junior engine, the Compound engine, the Steeple Compound, the Marine or Metropolitan type, the Horizontal and Vertical Cross Compound Corliss, the Three-cylinder Compound Corliss, and finally the Steam Turbine. Some of these types are illustrated in these pages. It may be of passing interest to casually glance over them, noting their characteristic features.

In the Standard engine, which is a two-cylinder single expansion engine, usually operated non-condensing, we find the balanced piston valve employed with success, actuated by an inertia shaft governor located within the engine casing.

By removal of the shaft governor to the fly wheel and the valve chamber to the top of the engine cylin-

Interior, Main Aisle—Westinghouse Foundry at Trafford City

ders, the distance between cylinders is reduced sufficiently to obviate the necessity of a central bearing to the shaft.

In the Compound engine are embodied the principles of multiple expansion with a radical departure in steam distribution from the methods formerly or at present employed. Amid so many representatives of the receiver type, it stands today as the sole successful representative of the Woolf or non-receiver compound steam engine. Outside of general design, the difference between transition from failure to success has been largely traceable to the arrangement of the piston valve which simultaneously controls, through the agency of an inertia shaft governor, the exhaust of the high pressure and inlet of the low pressure cylinders.

Although the single-acting designs possessed excellent features, the necessity of larger powers gradually forced the return to the double-acting slow speed engine. At the Chicago Exposition, in 1893, was exhibited, in service, the first type of double-acting engine, the Steeple or Vertical Tandem Compound. These were direct connected to the first Westinghouse two-phase engine type A.C. generators, and formed a memorable exhibit.

In 1891 a new design was introduced; the Marine type. The engine is a vertical two-cylinder compound engine of moderate speed, equipped with a balanced piston valve on the high pressure cylinder controlled by an inertia shaft governor, and a double-ported balanced slide valve on the low pressure cylinder. A number of these engines of 500 HP capacity are operating in the model power plant of the Pennsylvania R. R. Company's Union Station at Pittsburg, Pa. Designed to operate non-condensing with a cylinder ratio of 1 to 2½, the engines have, upon test, given a steam consumption of 20 lbs. per 1 HP steam pressure 150 lbs., back pressure 1 lb. Tested on vacuum, they showed a steam consumption of from 15 to 16 lbs. per IHP.

With the demand for still higher powers came the development of the Westinghouse-Corliss Engine, the design of which, although in general more or less conventional, nevertheless, embodies several distinctive features. Perhaps the most important of these is the use of poppet steam valves to accommodate the use of superheated steam. In Europe, superheated steam has within recent years made extensive progress, but in this country its use and introduction has been seriously handicapped, partly by lack of experience with it, and largely by the natural hesitation of engine builders in changing their designs to suit higher steam temperatures. With Corliss valves, the use of superheated steam has not proven feasible, due to the difficulties encountered in expansion of parts and in securing efficient lubrication. With poppet valves, these difficulties have been overcome, and in the designs of Westinghouse-Corliss engines — notably those installed in the power stations of the New York Edison Company and the Boston Elevated Railway Company — we find the first example of the serious adoption, upon a large scale, of superheated steam in power station work in America.

The Three-Cylinder Compound Corliss, first installed in the New York Edison station, may justly be con-

Data		Results of Tests		
High pres. cyl.	43½x60″	Load, IHP	5442	3088
Low pres. cyl.	75½x60″	Steam, Lbs.	185.6	187
Ratio of expansion, 1 to 6.02		Vacuum, Inches	27.25	24.4
Length over all, 41 ft.		Water per IHP	11.93	12.62
Width, 23 ft.		Over all eff'ncy	95.2	93.9
Height, 34 ft.		Dry Saturated Steam		
Speed, 75 r. p. m.				
Steam pressure, 175 lbs.				
Vacuum, 26 in.				
Superheat, varying				

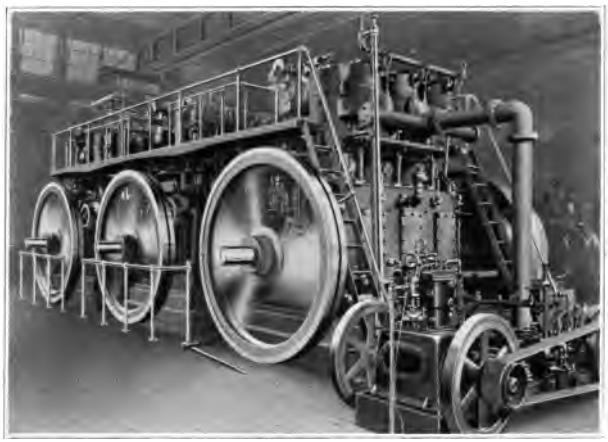
sidered typical of the highest of engine design. Eleven of these units are in operation, each direct connected to 3,500 KW A.C. generators and rated at 5,560 indicated horse power, with a maximum overload of 8,340 HP.

An interesting feature peculiar to this type of engine is the irregular spacing of cranks. Instead of 120°, they are spaced at 126°, 133° and 101° respectively, the object of this departure from uniform spacing being to decrease, at normal loads, the angular displacement from uniform rotation, thus correspondingly decreasing the requisite fly wheel capacity and incidentally the difficulty of operating alternating current generators in parallel.

The New York Edison station probably represents the limit of compactness in power station design where reciprocating engines are employed. A comparison of the five large New York power stations will illustrate:

Station	Type of Engine	Sq. ft. per rated HP	
		Normal	Max.
N. Y. Edison...	Vertical 3-cylinder Compound.	.64	.42
Metropolitan...	Vertical Cross Compound	.98	.74
Kingsbridge....	Vertical Cross Compound	1.09	.79
Manhattan	Horizontal Vertical Cross Compound..	1.23	.82
Rapid Transit..	Horizontal Vertical Cross Compound..	1.45	.93

A most important branch of the East Pittsburg industry is that devoted to the manufacture of gas engines. Attracted by its superior thermal efficiency, The Westinghouse Machine Company in the early 90's took up its development, and in 1896, introduced the type into which experimental development work had crystal-



Power-house Westinghouse Machine Co.

lized, viz: a multi-cylinder vertical, single-acting, enclosed type engine, working on the Beau de Rochas or four-stroke cycle with constant quality of explosive mixture. In opposition to the established precedent of hit-and-miss governing, the engine was equipped with a centrifugal governor proportioning to the load on the engine the quantity of mixture at every inspiration stroke. This improvement led to the adoption of the engine for generator driving, and today this application constitutes its most promising field for future developments. Engines up to 1,500 Brake HP have been built, and one of double this size is now under construction. Natural, Coal, Blast Furnace and Producer gas have proven entirely suitable for power purposes, yielding about the same thermal efficiency, viz: 10,000 to 12,000 British thermal units per Brake HP hour.

The problem of the successful operation of A.C. generators in multiple by gas engines was for the first time in America solved upon a practical scale in the power-house of this company and also in that of the Union Switch and Signal Co., Swissvale. This has

opened the vast field of A.C. power work, resulting in the development of the Westinghouse heavy duty double-acting gas engine. Built both horizontal and vertical, according to requirements, and embodying many features of established steam engine practice, this type represents the culmination of advancement in the utilization of gas power. The engine is built in either tandem or cross tandem arrangement, the latter with cranks set at 90° angularity, thus giving four power impulses per revolution. Cylinders, pistons, combustion and valve chambers are water cooled, and starting is accomplished by compressed air stored in tanks.

This type has proven suitable for direct connection to engine type A.C. generators of the usual frequencies. In San Luis Potosi, Mexico, a model gas power plant recently commenced operation with three 250 HP three-phase units using producer gas. It serves the city with light and power.

The awakening of the interest of the American engineering public to the advantages of the steam turbine is now an interesting historical fact practically identified with the beginning of the present century. Through the indefatigable efforts of the Hon. Charles A. Parsons, the turbine had won a permanent standing in English territory, and in 1896, manufacturing rights

Multi-Cylinder Gas Engines on Testing Floor

Corliss Erecting Bay

were acquired by The Westinghouse Machine Company. Dating from the first installation in 1899 at the works of The Westinghouse Air Brake Company, the Westinghouse-Parsons turbine has, within a period of five years, been introduced to the extent of 200,000 HP in American and British territory, and the output of the Parsons type of all builders' approximates a total of 60,000 HP. annually.

Realizing that the most important field of the turbine lay in the generation of alternating current electric

Horizontal Double-Acting Gas Engine

power, the operations of the company have been, up to the present time, confined to this field.

The turbo-generator has thus been developed simultaneously with the American Parsons turbine, and starting with a unit of moderate size — 400 KW — the sizes manufactured have gradually increased simultaneously with the increase of confidence in the turbine until at the present time turbine power units ranging up to 5,500 KW capacity are being manufactured. Eleven of these units are in various stages of completion in the American and British factories. The advantages of the turbine are too well known to require comment here, but closer acquaintance resulting from a visit to the shop cannot fail to further emphasize its extreme compactness, its simplicity of construction, the facility with which it is erected and operated, and the economy which it shows under test. The construction of the Westinghouse product is also no secret. A visit to the shop is further profitable by a more thorough knowledge of details: The simple method of blade mounting; the water-sealed packing glands surrounding the shaft; the automatic speed limit, the automatically controlled secondary valve, enabling the turbine to carry enormous overloads; the oil cushioned journals employed on smaller sizes; the construction of the rotating field of the alternator; and the methods of obtaining brake and electrical tests.

The testing department justly forms a most important part of the manufacturing equipment, in that the results obtained convey precisely the information desired of a prime mover, viz: the steam consumption per unit of useful work done at the shaft or generator terminals. Tests are regularly conducted from zero to full and overloads under steam pressures up to 150 lbs. with superheat from zero to 300° F. and vacua ranging from 29-30 of the barometer reading down to atmospheric pressure. The following results obtained upon a comparatively small machine — 400 KW — will give an indication of the progress that has been made by the turbine:

	180° Superheat		100° Superheat		Dry Steam	
Load BHP.....	763	592	759	595	728	593
Steam Pressure Lbs....	151	154	150	156	153	154
Vacuum in. (30″).....	27.9	27.9	27.95	27.9	27.9	27.9
Superheat Deg. F.....	182	181	104	109	.....	.....
Water per BHP hr.....	11.17	11.45	12.07	12.41	13.63	13.91

A wealth of information of like character is vailable to the visitor, which reflects not only the achievements of this one manufacturing concern, but also serves as an indication of American industrial progress in one of its most important branches.

Westinghouse Foundry at Trafford City

Bird's Eye View Union Switch & Signal Co.

Union Switch & Signal Co.

THE works and the home office of the Union Switch & Signal Co. are situated at Swissvale, Pa., on the main line of the Pennsylvania Railroad, eight miles east of the Pittsburg Union Station. The buildings cover an area of 169,200 square feet, and the shops have a floor area of 290,520 square feet. In the works and home office about 1,000 men are employed, and the outside force employed on installation runs from 300 to 600 men, according to the number and size of contracts in process of execution.

The company was organized in 1882, and Mr. George Westinghouse is the president. This concern was formed to carry on the work of protecting railroads by the interlocking of switches and signals, and by block signals of various kinds, and its product now embraces a great variety of apparatus for the protection of moving trains; but a considerable part of its product is frogs, switches and crossings, which business was developed naturally as auxiliary to the interlocking and signaling business.

At the outset the interlocking was entirely by mechanical apparatus, and the Union Company early secured control of the famous Saxby & Farmer devices, the patents on which have gradually expired; but the Saxby & Farmer machine, as improved from time to time, is still considered by the Union Company the best mechanical interlocking. It builds, however, half a dozen other types.

The Union Company very early took up power interlocking, and installed hydraulic and hydro-pneumatic machines. These were soon replaced by the Westing-

house Electro-pneumatic machine, which quickly established itself as the highest development of power interlocking, and within the last thirteen years the Union Company has booked orders for 4726 electro-pneumatic levers. Its installations of this class of interlocking protect many of the most important passenger terminals in the world; as for example, at the Pittsburg, the Broad Street, Philadelphia, and the Jersey City Terminals of the Pennsylvania Lines; at the Boston Southern Station, and at the St. Louis Union Station. Until recently the installation at the Boston Southern Station was the largest, the machine there having 143 levers. Quite recently, however, the Company has installed at St. Louis a machine containing 215 levers worked in combination with two smaller machines. These three electro-pneumatic machines perform a duty that would require 800 mechanical working levers. In this system the movement of switches and signals is effected by compressed air, distributed from

Automatic Block Signals P. R. R.—Westinghouse Electro-Pneumatic

a central station, the operating valves being controlled by elecricity. The Company has recently brought out a system of interlocking in which all of the work is done by electricity. Each of these systems has its special advantages, and the choice of the system must be governed by local conditions.

Early in the development of the art of automatic block signaling the Company brought out an electro-pneumatic system of automatic signaling. Here the power to clear the signals is compressed air, which is distributed along the line of railroad, either way from central compressing stations. The valves which admit the air to the signal cylinders are actuated by electricity, and are controlled by track circuits in such a way as to make the movement of signals depend entirely upon the progress of trains through the blocks. A good example of this class of signaling may be seen on the Pennsylvania Railroad leading out of Pittsburg. It is extensively used in other places and on other roads. This apparatus is simple and robust, and there are great advantages in having ample power for clearing the signals, but the cost of distributing the power is considerable, which fact has led to many efforts to introduce other forms of automatic signaling.

A few years ago the Company produced a semaphore signal actuated by an electric motor which is controlled through a track circuit precisely as the electro-pneumatic signals are controlled. This has been very successful, and up to the end of July, 1904, the Company has booked orders for 5840 signals of this type. Its electro-pneumatic signals at that date numbered 6250. It will be seen that the electric motor signal is rapidly overhauling the electro-pneumatic, a fact which is due entirely to the difference in cost of installation. At the same cost the electro-pneumatic would almost always be preferred.

The Company makes several other styles of automatic signals, as well as simple mechanical signals for telegraph blocks and for other purposes.

Westinghouse Electro-Pneumatic Interlocking, Boston Southern Station

A type of block signals much used in England, but not used in the United States, is the controlled manual, and the Union Company developed some excellent apparatus for this kind of signaling, which is used on the New York Central more extensively than anywhere else in America. The present tendency is to replace manual signals by automatic in order to reduce the wages account, and now there are not many calls for the controlled manual system.

The progress of the use of electricity as a motive power for heavy and fast traffic has made it necessary to bring forward still another system of signaling. It is obvious that the use of the rails for the return of propulsion current introduces a difficulty in the control of signals by a track circuit. This difficulty the Union Switch & Signal Company has met by using alternating current for the track circuit. Direct current is taken from the distribution system for propulsion and passed through motor generators, and alternating current at a low voltage is delivered on the rails for the track circuit. A selecting relay is introduced which is sensitive only to the alternating current, and thus the direct return current is prevented from interfering with the control of the signals. This system was first put in practical use on the North Shore Railway in California, where a number of signals were installed in November of 1903. A very important application of this system is now in progress on the lines of the Interborough Rapid Transit Co. in New York City. The requirements there are very severe. The trains are heavy, fast and frequent, and a great quantity of propulsion current must be dealt with. The express tracks are to be protected by a complete automatic block system, and curves and stations on the local tracks will also be protected by block signals. There are numerous turnouts and crossovers, and other points where interlocking must be introduced, and the interlocked signals must be controlled by the block signal circuits. Furthermore, automatic trips are designed, to come into action

and stop a train in case a signal at danger is passed, and these also are controlled through the signaling circuits. This work is now approaching completion, and at the time of writing these words it is expected that much of the signaling will be in condition to be tested out and instruction trains will be run by the middle of August. The signals in the sub-way portion of this line, which is much the greater portion, are light signals only, showing red for "stop," green for "proceed," and yellow for "caution." Out of doors semaphores will be used with the same arrangement of colors for night signaling.

It is impracticable to give here anything more than a general account of the work of this Company, but at its home office in Swissvale there are excellent arrangements for showing the apparatus made, full size and in working condition.

Electro-Pneumatic Block Signals, New York Subway

Bird's Eye View of Westinghouse Traction Brake Co.'s Works

Westinghouse Traction Brake Co.

THE product of this Company consists of power brakes for street railway service. It has adapted the regular Westinghouse railway schedules to the use of street railway equipments and has perfected axle and motor-driven compressors to take the place of the steam-driven compressor, usually found on steam locomotives. Its general office is in New York City, but all the apparatus is manufactured at the works of the Westinghouse Air Brake Co., at Wilmerding, on the Pennsylvania railroad, 15 miles east of the Union station at Pittsburg, Pa. This factory is by far the largest brake building plant in the world, employing ordinarily about 3,000 men, and having a capacity of over 1,000 brake sets per day. The plant was erected in 1889, and has been added to from time to time to meet the growth of the brake business. The engraving shows these works and part of the surrounding town. In the works there are about 9 acres of floor space; while the works and yards occupy about 30 acres.

The general office building of stone and brick is situated on the side hill opposite the works and a short distance from them. The various offices of the Company occupy the second and third floors, part of the basement and first floor being given up to the Young Men's Christian Association. The general arrangement and fittings of these offices are elegant and most suitable for the administrative department of such a prominent and long established company. The situation and surroundings of the building are beautiful and the views from the windows looking over the valleys and shops are exceptionally picturesque.

Central Aisle of Machine Shop

The central power station consists of four 400 KW Westinghouse-Parsons steam turbines direct connected to 2 phase alternating current generators 440 volts. The current is distributed to about 60 induction motors throughout the works aggregating nearly 1,300 horse power.

One of the most unique features of these works is the iron foundry where iron is poured continually, the molds being set on movable tables which pass in front of the moulding machines, core makers, cupolas and cleaning floor. The cut of the iron foundry, page 114, will give an idea of how this arrangement is carried out. The daily capacity of the foundry is about 200 tons whereas the number of men employed is only about 550.

Above is shown the central aisle of the long machine

shop building. The castings from the iron foundry are brought into the lower floor of this aisle for distribution. The large iron castings are machined on the lower floor to the right and left. The small iron castings are machined in the gallery on the right, while the brass is all finished in the gallery on the left. There are employed in the machine shop about 1,600 men.

Below is shown a portion of the gallery in which the smaller iron parts are machined. The machines are operated by shafting in short lengths driven by small induction motors. Due to the large number of brake equipments being manufactured every inch of available space has necessarily been utilized. The pipe rising from the floor back of each machine contains wires connected to the incandescent lamp which swings from the upper end so as to furnish light to the machinist.

View in Gallery

An industrial railway connects the various buildings and parts of the yard, it contains about 6,000 feet of track and the locomotives are electrically propelled by storage batteries. Steam railway connections are also

made with the Pennsylvania Railroad and the Westinghouse Interworks Railway.

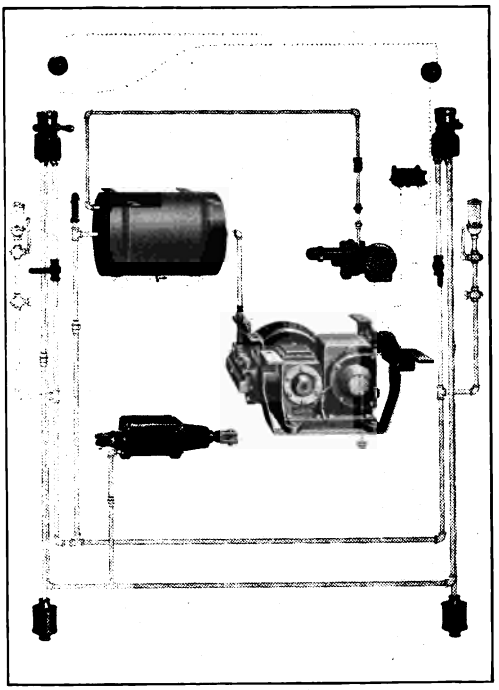
This cut shows a corner in the motor compressor test room where every compressor that is made for supplying compressed air for the various air brake equipments of electrically operated traction lines, is thoroughly tested both for efficiency and endurance. The two compressors shown with gear-case cover removed have motor and pump-shaft gears connected by the Morse

Motor Compressor Testing Room

silent running frictionless chain. The Westinghouse motor compressors are however also arranged for regular gear-drive with herringbone gears.

The accompanying diagram illustrates the equipment known as the Straight Air Brake. It is the same in principle as the original Westinghouse brake, consist-

ing of compressor for obtaining the compressed air and reservoir in which it is stored; a cylinder, the piston rod of which is connected to the foundation brake gear in such a manner that when the air pressure is admitted



Straight Air Brake Equipment

to the cylinder the brake shoes press against the wheels thereby applying the retarding force. The principal parts of this equipment are the compressor, governor, brake cylinder and operating valve.

Foundry

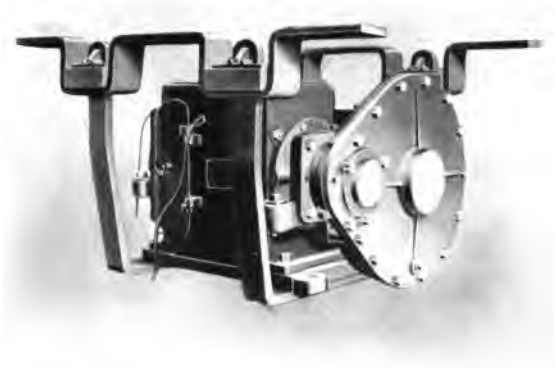
The governor illustrated consists of a single-pole, double-break, snap switch operated by a small air cylinder and slide valve arrangement so that when a given maximum pressure is obtained in the reservoir the switch is thrown to a position to break the circuit

The Governor

to the motor; and when this pressure falls to a predetermined minimum the switch is thrown to the other position so as to make the circuit to the motor and cause the pump to operate.

The motor-driven compressor consists of a horizontal, duplex, single-acting pump connected by gearing or chain drive to a small four-pole, direct-current, series motor.

The operating valve illustrated consists of a slide valve connected through rack and pinion to a swinging handle so that when this handle is in certain positions, ports in the slide valve seat are made to connect either the reservoir to the brake cylinder and admit air for



Motor Driven Compressor

applying the brakes, or to connect the brake cylinder to the atmosphere and release them. Of course, by proper manipulation the pressure of the brake cylinder may be gradually raised or lowered to any desired extent. A

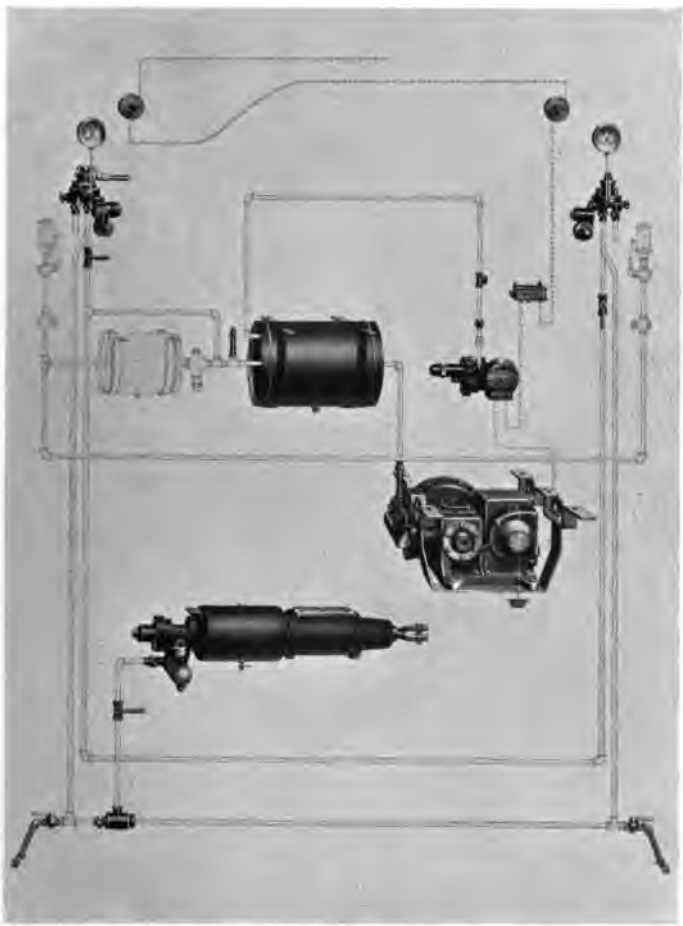
gauge placed on the top of the valve is connected to cavities in the valve body so that one hand will show reservoir pressure and the other brake-cylinder pressure.

The Axle Driven Compressor is sometimes required in place of one operated by a separate motor. It is installed in the Straight Air Brake equipment quite the same as the Motor Driven unit, and consists of a horizontal, double-acting, single-cylinder, gear-driven pump, arranged so that it can be mounted upon the same axle with the car motor. The accompanying cut shows the air cylinder in ghost outline and the piston and crank shaft full.

Axle Driven Compressor

The accompanying diagram shows the equipment for automatic brakes such as are commonly used on the steam railway systems. This equipment is always preferable where cars are operated in trains, because with it the breaking in two of the train or any disruption of the air brake system immediately and automatically applies the brakes and brings the train to a stand-still.

The apparatus going to make up the equipment is very similar to that of the straight air brake with the exception that an auxiliary reservoir is connected to the



Automatic Brake Equipment

brake cylinder, and a triple valve makes proper connection between the train pipe, auxiliary reservoir and brake cylinder, so that when the brakes are applied air flows from the auxiliary reservoir to the brake cylinder; and when they are released the brake cylinder is connected to the atmosphere and the auxiliary reservoir is recharged from the train pipe and main reservoir. The operating valve in this case is of different design and construction because of the fact that with the automatic system the train pipe pressure is reduced to apply the brakes and increased to release them, whereas with the straight air the opposite occurs.

The Operating Valve

This system has been adopted in many places because of its simplicity and also low cost of maintenance. The compressor and governor of the systems just described are replaced with storage reservoirs designed for high

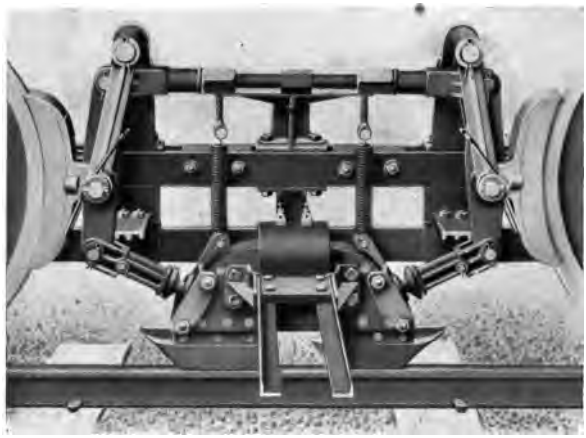
pressures and a reducing valve which supplies the operating system with air at the usual pressure. The storage reservoirs are connected by piping with coupling fittings on each side of the car so that at a charging station the usual hose coupling can be quickly coupled and the storage reservoirs recharged.

The accompanying cut will show how simple is this recharging operation and how little space is required for the recharging connections. The car shown in the cut

Charging Brakes on Car with Storage Equipment

is one of the St. Louis Transit Co.'s system, operating between the city of St. Louis and the World's Fair grounds, all of which are being equipped with the Westinghouse Traction Brake Equipment.

The accompanying cut shows the Westinghouse Elec-

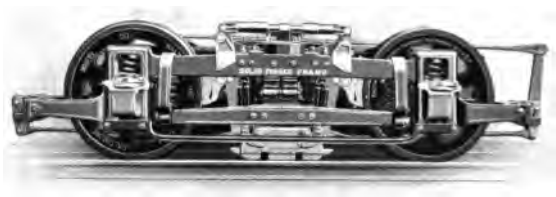


Magnetic Brake

tro-Magnetic brake which has been extensively adopted for various classes of traction service and proven eminently successful. This is the brake which was adopted by the City of Bath, England, for the Municipal Tramways, after extensive investigation and trials.

The high speed attained by the street cars in the city of Pittsburg has been very largely made practicable and safe by the application of this brake, which actuates both on the rails and wheels. Unlike other track brakes the drag of the rail shoes is not due to the weight taken from the force with which the car bears on the rails through its wheels. The pressure of the track shoes on the rail is derived entirely from the pull of the electro magnet of which the shoes form the poles and the rails the armature. The weight of the car upon the rails remaining practically unimpaired and may, therefore, be utilized to the fullest extent for the braking force applied through the customary medium of the wheels.

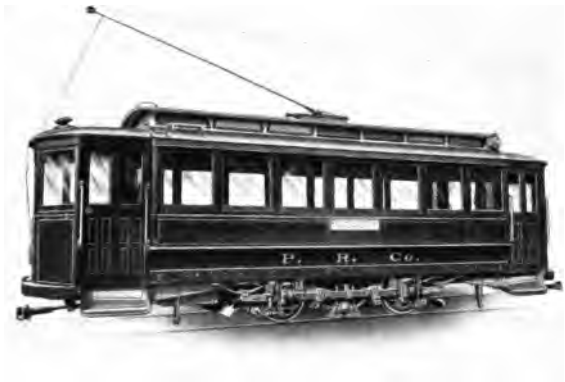
Another and important advantage of this brake is



Brill Truck Equipped with Magnetic Brake

its independence of the trolley circuit, the current which energizes the magnet being generated by the motors transformed to generators. This is done through proper arrangement in the controller so that when it is desired to apply the brake the motor leads are reversed and the momentum of the car compels the motors, now generators, to supply such current as is necessary for the magnets. Immediately upon being energized the track shoes are thrown into contact with the rails and the sliding friction forces the magnet,

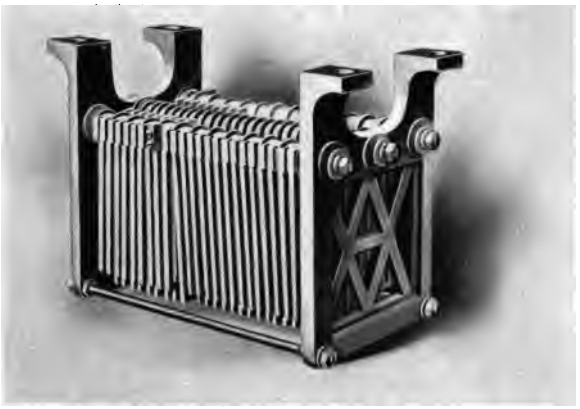
Works of American Brake Co.



Car of Pittsburg Railways Co.

which is elastically suspended, toward the rear wheels thus applying the shoes to each pair of wheels through the system of levers shown in the accompanying cuts. Thus to the ordinary retardation of the wheel shoes is added that of the track brake and also the back

Pittsburg, McKeesport & Connellsville Car



Grid Resistance

torque of the motors. For controlling the current supplied by the motors, its E. M. F. is divided between the electro magnets and diverters in such a ratio as to cause such braking force as is required. These diverters may be simply grid resistance or may be placed under the seats in the car and utilized as heaters

Heater

during cold weather. In this way both braking power and car heating are obtained without extra cost.

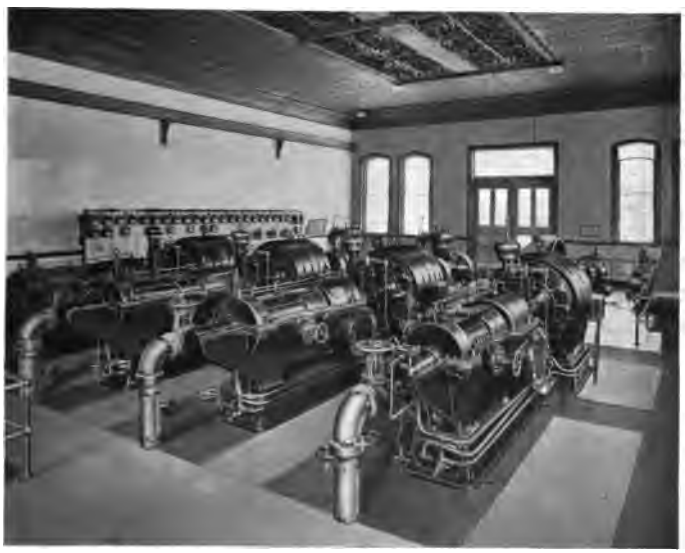
Other interesting features of the magnetic brake of interest and great value are: since the current generated by the motors declines with the speed during a stop the increased coefficient of friction at the lower speeds

General Offices

is thereby offset. In bad weather when the condition of the rails is liable to be accompanied by wheel-sliding, the braking force operating the wheel brake is correspondingly reduced so that the force of application of the wheel brake is automatically proportioned to the rail friction which rotates the wheels. If by chance the wheels should slide, the magnetising current

at once ceases and the pressure of the brake shoes upon the wheels is instantly relaxed so that rotation of the wheels is resumed without injury or loss of time.

Industrial Railway



Power House Westinghouse Traction Brake Co.

Street Scene, Pittsburg
Illuminated by Nernst Lamps

Nernst Lamp Company

THE development of the arc lamp, the birth of the carbon filament incandescent lamp, and the advent of the Nernst lamp may be regarded as the three great epochs in the annals of commercial electric lighting. The latter and more recent of the trio is to be regarded as a means of filling the gap and covering the field which has long existed between the arc and incandescent lamps in electric lighting.

The Nernst lamp is the result of an invention of Dr. Walter Nernst, a German physicist. This invention consists in using as a light-giving body a filament of porcelain composed of rare earths, which is maintained at an incandescent temperature in the open air by the passage through it of an electric current. Other incandescent filaments burn out in the air and have to be surrounded by a glass globe in which a vacuum is maintained. The filaments used in the lamp are also characterized by the fact that at ordinary temperatures they do not conduct electricity, and must be heated to a red heat before they will transmit the current. These differences from other lamps bring about other requirements which altogether constitute the present Nernst lamp.

The lamp in embryo was first brought to the attention of Mr. Geo. Westinghouse in 1897, and early the following year Dr. Nernst came to East Pittsburg, at Mr. Westinghouse's request, to exhibit the invention. Foreseeing its great possibilities, Mr. Westinghouse promptly undertook its commercial development and introduction in the United States. Under the guidance of Mr. Alexander J. Wurts, Henry Noel Potter and a small body

of technical experts, the experimental work was at once started in the Westinghouse Company's shops, and in two years' time the work of development brought about a practically operating and economical lamp.

In the fall of 1901, the Nernst Lamp Company was organized, with Mr. Westinghouse as President, and Mr. A. J. Wurts as Manager. Shortly afterwards the Company took up its quarters in the present five-story factory building on Garrison Place and Fayette St., Pittsburg, and the commercial production and sale of the lamp began.

The building occupies a ground area of 20,000 square feet, with a total floor area of 101,000 square feet. This building is equipped with all the modern conveniences of an up-to-date factory, including the advanced ideas

for the welfare of the employees. Thirteen District Offices have been established in the principal cities, insuring prompt attention to the customers' needs in any part of the United States.

With units varying in size and light intensity from 20 to 500 candle power, the Nernst lamp is adapted to almost every class of service, both interior and exterior. The following is a list of the Company's present product, together with the respective light intensities of the different units:

NERNST LAMPS	INTENSITY
Six-glower Lamp; Indoor, 220 volt type.....	500 C. P.
Six-glower Lamp; Outdoor, 220 volt type....	500 "
Three-glower Lamp; Indoor, 220 volt type..	200 "
Three-glower Lamp; Outdoor, 220 volt type..	200 "
Two-glower Lamp; Indoor, 220 volt type....	125 "
Two-glower Lamp; Outdoor, 220 volt type..	125 "
Single-glower Lamp; Indoor, 220 volt, 88 watt type.....	50 "
Single-glower Lamp; Outdoor, 220 volt, 88 watt type.....	50 "
Single-glower Lamp; Indoor, 110 volt, 88 watt type.....	50 "
Single-glower Lamp; Outdoor, 110 volt, 88 watt type.....	50 "
55 watt, Indoor 220 volt type.....	25 "
44 watt, Indoor 110 volt type.....	20 "

These units are supplied with globes and shades of various styles to suit different conditions, and may be operated on alternating current circuits of any commercial frequency.

The first public demonstration of the Nernst lamp was made at the Buffalo Exposition in 1901, the interior of the dome of the Electricity Building being illumin-

ated with six-glower lamps in festoons. Six months prior to this time, however, a number of trial installations had been successfully operated. Since that time, the growth of the Nernst lamp industry has been steady and sure. By virtue of its many superior characteristics, the lamp has been extensively adopted throughout the country, and is now generally recognized as an important factor in commercial electric lighting.

In addition to the Company's exhibits in the Machinery and Electricity Buildings, the lighting of the Illinois State Building, the Brazilian Building and numerous concessions on the Pike, as well as private exhibits at the St. Louis Exposition, one of the special applications of the Nernst lamp is commercially demonstrated in the lighting of the Art Palaces; a total of 4,780 glower units being used for this purpose.

View of Nernst Lamp Company's Works

Aside from the World's Fair installations, the Company has placed in service throughout the United States 64,216 Nernst lamps of different types; making a total of over 130,000 glowers in service.

The beautiful sunlight quality of the light is one of the distinguishing features of the lamp. Its efficiency is equal to that of the best modern arc lamps and is twice that of the ordinary incandescent electric lamps.

When operated in accordance with the recommendations of the manufacturers, the cost of maintaining Nernst lamps is practically the same as for other electric illuminants. The Company is prepared to furnish lamps in large quantities, a sufficient stock being kept on hand to insure prompt delivery.

Heavy Gear Department, R. D. Nuttall Co.

R. D. Nuttall Company

WHAT is claimed to be the largest and most completely equipped gear cutting establishment in the United States, if not in the world, Pittsburg has in the R. D. Nuttall Co It enjoys all the necessary facilities for the manufacture of gearing of every description, and in fact everything that can be classed as "gearing"; a special department in these extensive works being also devoted to the manufacture of trolleys for every electric haulage service.

The premises they occupy have a floor surface of 75,000 square feet, one portion being a six-story structure, while the powerful machinery used in cutting heavy gears is housed in a one-story extension, lofty and roomy so as to insure abundant light.

The various shops are equipped with the latest machines and tools for the production of "cut" gears, to which the company's exclusive attention is given, much of the machinery employed being of a special character. Among these machines is a large gear cutter, a unique machine with few if any equals in capacity, capable of cutting spur gears up to thirty feet in diameter by sixty inch face and, with some minor changes, it can be adjusted to cut gears of any diameter, limited only by the available floor space. Other special tools include machines for cutting worm gears up to 72 inches in diameter, spiral gear machines for spirals up to fifty-two inches in diameter, and machines for turning out internal gears and racks.

The entire plant is electrically operated, power being furnished by four 125 HP Westinghouse three-cylinder gas engines, direct connected to electric generators,

View in Gear Cutting Department

and 1-85 belted gas engine, all using natural gas. Various tools have their own motors and the principal shops are divided into electrical sections. Many tools are also equipped with a variable speed countershaft.

Through the center of the shops in which large work is handled, tracks are laid down on which cars are run, carrying material from one machine to another through the different steps of manufacture. The main aisle of the heavy gear department is also equipped with a 20-ton electric crane, and the motor gear aisle is equipped with pneumatic hoists.

In addition to special machines which have been mentioned there are upwards of 100 gear cutting machines employed in the works, besides a full complement of auxiliary machines, drill presses, forging presses, etc.

On the main floor of the works are located the heavy gear, motor gear and pinion, smithing and forging departments. A view of the aisle in the former, which is equipped with the most powerful machines for cutting gears, is shown elsewhere.

The motor gear department is one of the most interesting in the works. All machines in this department are supplied with lubricant by pipes leading from a single pump and their drainage is accomplished in a similar manner.

The trolley manufacturing department handles another very important branch of the company's business. Here are manufactured and assembled trolleys for street railway work, mine and industrial haulage, locomotives, etc., and this may be regarded as an important adjunct to the company's immense business in motor gears.

On the third floor is located the fully equipped pattern department, and on the fourth floor are accommodations for the storage of patterns, the company's list covering more than 6,000 of every conceivable type.

The fifth floor is used for machining material for small gears, and tool making, and on the sixth floor is located the small gear cutting department.

The works employ an average of two hundred men, nearly all skilled mechanics.

A Few Gear Cutting Machines

Standard Underground Cable Co.

THE Standard Underground Cable Company was organized in the City of Pittsburg, 1882, by Mr. Richard S. Waring, whose later interest in the Fowler-Waring Co., of England, gave his name to that Company. The Standard Underground Cable Co., from its beginning, has been properly regarded as a Pittsburg corporation, since its Directors and Officers, from its inception, have been connected with prominent commercial, manufacturing and banking interests.

It was the pioneer American manufacturer to produce lead-covered cables for transmission of electricity, and it has also led the way in many important developments which have now come to be looked upon as essential manufacturing and trade methods; such, for instance, as the application of the lead sheath to the cable core by means of the hydraulic press, the application of tin to the lead sheath in the form of a coating; the manufacture of the approximately flat or duplex type of cable; and the installing and guaranteeing of its cables under working conditions.

It was also the pioneer American manufacturer to issue a hand-book of technical information dealing with subjects allied to cable manufacture and installation, such as temperature rise in underground cables,— formation, weights and resistance of copper strands,— "Skin effects" with alternating currents,—electrostatic capacity and insulation resistance for varying materials and sizes of conductors,— preventive measures against damage to lead sheaths by electrolysis,— and field and laboratory methods of testing for conductivity, electrostatic capac-

ity, faults, etc. This "Hand-book" contains not only much information along the lines mentioned, but includes detailed information as to descriptions of the varied output of the Company, including such miscellaneous accessories as are needed in connection with bare and insulated wire and cable installation, as also detailed working directions for placing, splicing and connecting electric cables. It has, for many years, been a recognized standard of the trade and has literally a world-wide circulation.

3-0 B. & S. G. Triplex Cable for interborough Rapid Transit and Manhattan Ry. N. Y. (11,000 Volts Service)

The regular output of the Company is not confined to cables for underground use solely, but includes copper rods, also wire and cables, both bare and insulated in all styles suitable for use as conductors of electricity.

This Company operates at Pittsburg, Pa., Factory No. 1, its original plant (now greatly enlarged and re-equipped) for the manufacture of magnet wire, weather-proof wire and cable, and fibre and paper insulated lead-

covered cables of all kinds. At Pittsburg is also located the machine shops for the manufacture of wire and cable-making machinery, terminals, junction boxes, lightning arresters and accessories. Here is located the general laboratory in which extensive experimental work is conducted to determine the availability of different dielectrics and insulating compounds, and to note the effect of high voltage strains when applied to such dielectrics under different conditions. The apparatus in place is regularly used up to 60,000 volts and an ad-

1,000,000 C. M. Concentric Cable with Three Pairs of Pressure Wires. (Low Voltage Service)

ditional equipment for testing up to 100,000 volts, with a capacity of 125 kilowatts, is now in process of construction. While not overlooking the practical or commercial side of laboratory work, special attention has always been devoted to research and experiment in advance of the current commercial practice.

Factory No. 2 is situated at Oakland, Cal., and is equipped for insulating, papering, braiding and lead-covering cables, and for thoroughly testing the output of the factory.

The principal factories (Nos. 3, 4 and 5) are located on the outskirts of New York harbor at Perth Amboy, N. J., and are in direct connection via trunk line service and also by deep water transportation, with New York and other shipping points for home and export trade. Here are operated the Rod Rolling Mills, Wire Drawing Mills, Weatherproof Factory, and factories for making rubber insulated wires and cables, both leaded and un-leaded, and also fibre and paper insulated lead-covered cables, for any service.

Duplex Cable (2,200 Volts Service)

The aggregate floor space of the combined factories is about seven acres or 300,000 square feet, not including tracks, sidings and storage yards, which aggregate about as much more.

As typical of the class of installations made by this company, may be mentioned the following: Minnesota Brush Co. (now Minneapolis Gen. Elec. Co.), Minneapolis, 1890; Philadelphia Traction Co., Philadelphia, during 1893–4–5, at a cost of about $950,000.00; the Independent Elec. Lt. and Pr. Co., San Francisco, during 1898; Compania Explotadora de las Fuerzas, Hydro-Electricas de San Ildefonso, S. A., of the City

of Mexico, Mexico, 1901 (this order consisting of 5-wire low voltage and 3-wire high voltage circuits, cables protected with double steel tape armor, and laid directly in the earth); Cataract Construction Co. and Niagara Falls Power Co., Niagara Falls, N. Y., the complete telephone cable equipment for Kinloch Telephone Co., St. Louis; Cuyahoga Telephone Co., Cleveland, O.; Citizens' Telephone Co., Columbus, O.; Pittsburg & Allegheny Telephone Co., Pittsburg, Pa.; Maryland T. & T. Co., Baltimore, Md.; Rochester Telephone Co., Rochester, N. Y.; Frontier Telephone Co., Buffalo, N. Y.; New Telephone Co., Indianapolis, Ind.

Among the later more important work, may be mentioned that covering upwards of $2,000,000 worth of underground cables for the electrical equipment of the Manhattan Ry. Co., New York City, and Interborough Rapid Transit Co., New York City; this work is at present in progress, but is expected to be completed during the coming season.

The gross value of the yearly business of this company is at the rate of approximately $10,000,000 annually, and is drawn from the commercial centers of all the continents, including Japan and Korea in the Far East; from the valley of the Yukon, Alaska, on the north, to Puntas Arenas, South America (the southernmost city in the world), on the south, although naturally the largest proportion of its output is required in filling domestic orders.

Sterling Varnish Company

PITTSBURG is known chiefly for its production of iron and steel, but this alone does not make all her greatness. Smaller industries of every class, with specialists who have devoted their lives to the problems involved, may be found throughout the city and the adjacent manufacturing territory. The bringing together of these various industries naturally contributes to the bettering of all, for the reason that no one industry depends upon itself alone, but the manufacturers of raw materials must depend upon the manufacturers of finished products, and the manufacturers of finished products upon the manufacturers of raw materials, for mutual information and help in bringing their goods to the highest degree of efficiency. In no place in the world can this be done better than in Pittsburg, and this is emphasized in the products of the Sterling Varnish Company, which for more than ten years has been supplying a large share of the insulating varnishes used throughout the world.

. One of the principal limitations in the life of electric machinery is its insulation. No matter how good the design or how efficient the apparatus, it is useless unless its insulation can be maintained year in and year out. An inefficient machine or a poor regulating machine having good insulation is, on the whole, better than a machine having poor insulation and possessing the other characteristics, for the reason that the cost of repairs and the loss in revenue due to breakdowns of poor insulation may be greater than the extra economy gained by high efficiency.

Previous to 1890 or 1891 there had apparently been

little attempt to manufacture varnishes which were specifically intended for insulating purposes. About this time the Westinghouse Electric & Manufacturing Company took up the problem with various varnish chemists, including Mr. James Todd, of the Sterling Varnish Company. The result was a series of experiments lasting about two years, carried on jointly by Mr. Todd and the Westinghouse Company. The final result at that time was a varnish known as the "Sterling Extra Insulating Varnish." The use of this varnish effected a decided change in the insulation of dynamo electric machinery. Through its use the percentage of mica formerly used began to be reduced, the use of shellac with its troubles due to brittleness, etc., was reduced to a minimum, and the evolution of the present general type of insulation in the form of treated cloths, papers and tapes began.

When this varnish was adapted for use, neither the Sterling Varnish Company nor the Westinghouse Company, who had done the original work, considered that the experimental work was complete. Systematic experimental work was carried on by the Sterling Varnish Company looking to a bettering of its product, and through this work the evolution from the original varnish to its present high efficiency was accomplished. The remarkable increase in the use of this varnish, together with its introduction into new fields, gave the chemists of the Sterling Varnish Company constantly increased facilities for observing the effects of the application of the varnish and for studying the very exacting requirements which are imposed on insulating varnishes. The net result of this work has been the production of various classes of varnish to meet the new demands which are constantly brought about both by the introduction of electrical machinery into new fields and by the constantly increasing demands for perfection in both the new and the old apparatus.

The Sterling Varnish company, as a company, was incorporated in March, 1894, as a Pennsylvania State

Corporation, with a capital of $20,000, and the original works were built on the river bank below Allegheny Ave., in Allegheny City. The various changes and advances made by the company from that time to the present time have rapidly increased the investment until now its capital is $1,000,000.

Early in 1896 a conference was held at Schenectady between certain officials of the General Electric Company and certain men representing the firm of Ludwig Lowe & Company, Berlin, Germany, in which the subject of insulating varnish for use in the German factory was taken up, and the conclusions arrived at were that the varnishes made by the Sterling Varnish Company were superior to those made by any other manufacturers and that Ludwig Lowe & Company should adopt these varnishes for their insulating work.

The popularity of this product was soon as pronounced in Europe as in America, and in a very short time, through the apparatus manufactured by the numerous large firms using this product and through its very general use by operating and repair men, it can truly be said to have been spread around the world, and at the present time the Sterling Varnish Company's products are found in practically every manufacturing company's shops where electrical apparatus is manufactured or repaired.

Pittsburg may therefore be said to have seen the beginning of the insulating varnish industry, and at the present time the largest factory in the world devoted exclusively to this class of work is found in Pittsburg, the present factory of the Sterling Varnish Company being located on the banks of the Ohio River a short distance below the city proper.

The American business of the company is handled from Pittsburg, while the European business is consolidated under the management of Mr. W. S. Sample with headquarters on Brougham Street, Blackfriars Road, Manchester, England, with branch houses at London, Hamburg, Antwerp, Havre, Brussels and Genoa.

The Sterling Varnish Company's products include:
Sterling Extra Insulating Varnish.
Sterling Elastic Insulating Varnish.
Sterling Extra Black Finishing Varnish.
Sterling Black Air Drying Varnish.
Sterling Black Core Plate Varnish.
Sterling Black Insulating Paint
and
STERLING BLACK PLASTIC INSULATOR.

PITTSBURG ELECTRICAL
OPERATING COMPANIES

Pittsburg Railways Company

DATA on the origin and early history of the street railway business in Pittsburg is so meagre that the historian searching for detail will find himself digging in barren soil. No attempt has been made to keep an accurate record of the developments in this field which is now in the forefront of the march of American progress. To no other agency is so much credit due for the rapid spread of population and the growth and development of municipalities in this country. And yet how little we know about the business.

The first street car line in Pittsburg of which we have any record, was the old Citizens Passenger Railway, which began operations in 1859. The Company which operated horse cars from Penn Avenue and St. Clair Street (6th Street) to Penn Avenue and 34th Street, "the forks of the road," was organized by the father of Murray Verner, of this city, whose well founded early knowledge of the street railway business was acquired on this line. During the Civil War the line was extended from 34th street out Butler Street to the Allegheny Cemetery gate. The stables and car barn occupying the site of the present Butler Street station of the Pittsburg Railways Company.

Ten years later another extension was built from 34th Street out Penn Avenue to East Liberty. This was really the beginning of the street railway business in Pittsburg as about this time other lines were projected and built. From a small beginning of a few cars and less than a dozen miles of track the business has steadily increased until there is now in operation in the Greater Pittsburg about 2,000 cars and almost 500 miles of track.

The second line was the old Pittsburg, Oakland and East Liberty road, which began operations in the early seventies, the line extending from 4th Avenue and Market Street to Soho, then to Oakland and later to East Liberty. Shortly after this company began operating its cars the dreadful "Pink Eye" epidemic struck Pittsburg and practically put the company out of the business by crippling all the motive power. Being unable to get horses the company tried the old steam running motors which when not running off the track so scared what few horses that were left on the streets and the passengers who rode in the cars that the "dummies" as they were known, were soon relegated to the scrap heap.

About the time the old Oakland line began running the Pittsburg, Allegheny and Manchester, the Pittsburg and Birmingham, the Ormsley short line and Pleasant Valley lines were built and put into operation. Conductors were unknown in those days. The driver in addition to looking after his one or two horses, as the case may have been, attended to the collection of fares and helped persons on and off the cars. This was before the days of the fare boxes, when passengers were supposed to deposit their fare in a box. And when the cars turned in, the drivers had to also turn in and clean the cars after watering, feeding and bedding the stock. How different the working conditions of today. And still the car men are not satisfied.

To Messrs. P. A. B. Widener and W. L. Elkins, of Philadelphia, and their associates is due the credit for introducing rapid transit in Pittsburg. In 1887 they acquired a controlling interest in the old Pittsburg, Oakland and East Liberty horse car line and changed it to a cable road, the first in Pittsburg. The new era in the street car business began on September 12th, 1889, the cable line extending from 5th Avenue and Liberty Street to Shady Avenue, East End. The company began operations with twenty cars. When it was seen that the new motive power had cut the time of

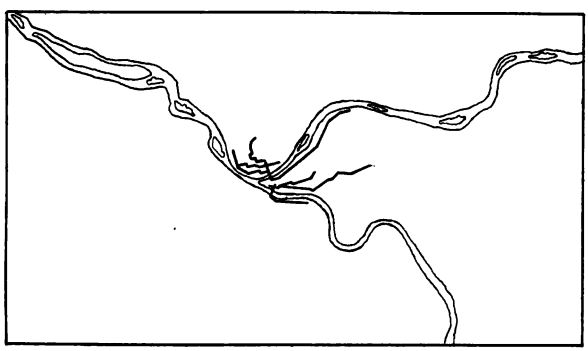
traveling from one end of 5th Avenue to the other — only five miles — from one hour and three-quarters to thirty minutes there was a rush of down town people to get out into the residence districts. There was a gratifying growth in car receipts. In 1886 the horse cars carried 2,045,756 passengers. In the third year of the operation of the cable road — '90 — these figures had increased to 8,649,788.

The second cable line was that of the Citizens Company on Penn Avenue — the pioneer horse car line — which began operations January 1st, 1889. Then came the central or Wylie Avenue line, February 24th, 1890. So quickly did the trolley follow the cable that investors who had planned and were about to supplant horse power with steam and wire rope, hesitated. It did not take them long to see that electricity was here to stay and further cable construction was abandoned. This was particularly true of the Pittsburg and Birmingham line which was purchased by the Chambers and McKee syndicate. The contract for building the cable road was just about to be awarded but the syndicate managers built an electric road instead.

The first attempt at electric traction in Pittsburg was in 1888 when a line was constructed from south 13th and Carson Streets to Knoxville Borough. At that time the only way of reaching the south side hill tops was by incline or roadway. There was one horse car line on Mount Oliver but the owners were not foolhardy enough to attempt to operate cars up and down the steep hills. About that time experiments in electric traction were being made. Residents of Knoxville and Mount Oliver formed a company to run cars that would be propelled by electricity. The Daft system was installed. To the query as to the feasibility of the cars climbing steep grades the Daft people replied they "Could climb telegraph poles." And they were right — the cars attempted to climb not only the telegraph poles, but every thing else, instead of staying on the tracks, conducting themselves peaceably and orderly as a well regulated car

should. A ratchet wheel was used on these cars, but they were not a success and after a number of spasmodic attempts to operate the road, the project was abandoned. Parts of this construction are still in evidence.

The next attempt at electric traction was made in 1889 — The Observatory Hill Passenger Railway in Allegheny. The trolley was hung over the trolley wire, there being no trolley poles connecting the car with the wire at that time. This line was fairly successful. On July 2, 1889, it was purchased by the Pleasant Valley

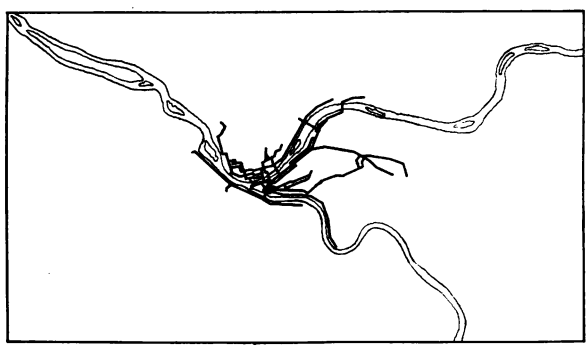


1869

Passenger Railway Company which at that time was controlled by W. H. Graham, D. F. Henry and associates. They changed the Pleasant Valley Road into an electric line and operated it until 1897 when they sold it to the United Traction Company.

The pioneer successful trolley in Pittsburg was the Second Avenue line, which began operating electric cars between Market Street and 4th Avenue and Glenwood, in March, 1890. Other roads had been running cars spasmodically before this, but the Second Avenue

line was the first to establish and maintain regular schedules. James D. Callery, the able president of the Pittsburg Railways Company, was the active aggressive spirit in the Second Avenue line. He foresaw the revolution that was about to take place in the street car business and quickly put his company in shape to take advantage of it. From Glenwood he pushed an extension of the Second Avenue line into Homestead, Braddock, McKeesport, Wilmerding, East Pittsburg and other Monongahela River towns. The flag of progres-



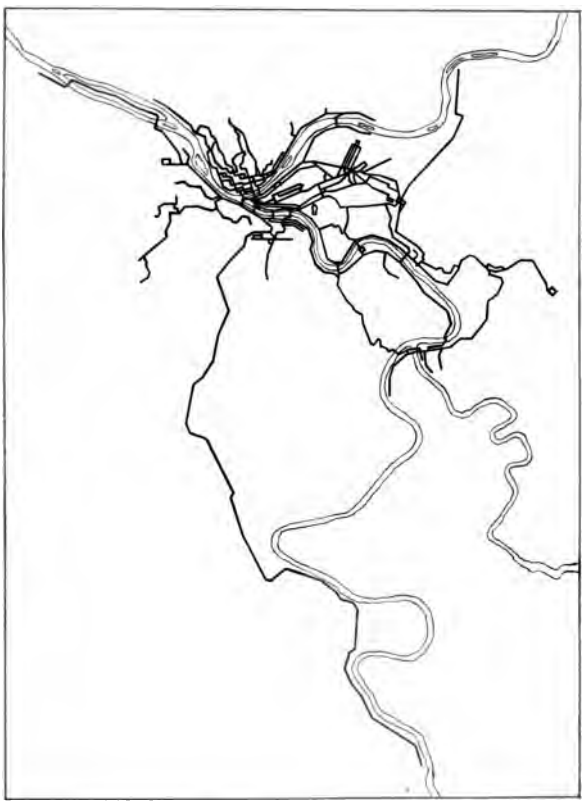
1890

sive street car management was quickly followed by a rush of travel, and the inadequate equipment of that day was taxed to the limit.

Prior to the organization of the United and Consolidated Companies, the big system was the Duquesne, which began operations May 18th, 1891, with 28 miles of track. This is now part of the Consolidated system.

Since the formation of the Consolidated and the United Systems, lines have been built to Charleroi, Verona, Duquesne and McKeesport.

The growth of the street railway business can best be illustrated by the accompanying diagrams, which show that the miles of track increased from 22 in 1869 to 114 in 1890, and to 445 in 1904. The number of passengers carried has increased to over 160,000,000 yearly.



1904

Allegheny County Light Company

THE Allegheny County Light Company was incorporated March 6th, 1880, with a capital stock of $90,000. For a short period following the organization of the Company its apparatus was located in various parts of the city. The first machine installed was a 40 Light Brush Arc Machine at the former works of the Westinghouse Machine Company on Liberty Avenue; another one was shortly afterwards placed at the plant of the Union Switch & Signal Company, at that time occupying a building in Garrison Alley. Another machine was operated in the plant of the Westinghouse Airbrake Company on Robinson Street, Allegheny. The old Exposition building and grounds, in Allegheny, were also lighted by similar machines, operated on the Exposition grounds.

The first permanent station of the Company was located on Virgin Alley on a lot 50 x 90 ft. An old building standing on this lot was remodeled to adapt it to the requirements of the Light Company. The machinery installed in this building consisted of Munroe Boilers, Westinghouse Standard Engines and 40 Light Brush Arc Machines.

The demand for arc lights increased rapidly from the start, until within a short time 10 of the 40 Light Machines were in operation. Up to this time the arc light was the only electric light in use. The first incandescent light was used in 1884; current for this purpose was furnished from a 75 Light, 110 Volt, D. C. Compound Wound Brush Machine. This first incandescent lighting service in Pittsburg was rendered to a restaurant and cafe at 52½ Fifth Avenue. Just as in the case of arc

lighting, the demand for incandescent light increased very rapidly, and it became necessary, from time to time, to install additional machinery. The new direct current machines were manufactured by a Pittsburg concern — the Westinghouse Company — and had a capacity of 500 16 candle power lights each, at the voltage of 110.

In 1886 an arc light plant was located in Allegheny, on East Diamond Street, to supply customers in that city with light. This plant was enlarged within a year after its installation. By the latter part of 1886 the business of the Virgin Alley plant had increased to such an extent that it became necessary to enlarge the plant very materially. Additional ground was purchased and a four-story brick and iron building was erected, including the old plant within its walls, so that the service during the time of construction was not interrupted. When the building was completed, it was equipped with new boilers of the Heine make, and 2 Wetherill Corliss Engines of 500 HP each. These machines were placed on the first floor and belted to the line shafting, on the second floor, from which the generators were driven.

Up to this time direct current was used for both arc and incandescent lighting. In 1887 the first alternating current Incandescent Lighting Dynamos were installed in the Virgin Alley plant. These machines were of the Westinghouse make and among the first machines of this type to be used in the United States. The capacity of the machines was 1,000 lights each. Within a year additional alternating current machines of 2,500 light capacity each were put in operation, illustrating, by this great increase in capacity, the very rapid development of alternating current work even at this early period. At this time all the lighting was commercial except that of the Monongahela Wharf, where 20 arc lamps had been operated from the machine installed at the works of the Union Switch and Signal Company in Garrison Alley, since 1881. This installation had been made to demonstrate to the city authorities the great advantage of arc illumination for city streets over the gas lamps then in

use. It is stated that this experiment was made at the earnest solicitation of a steamboat captain who had suffered great losses, in loading and unloading his goods upon the wharf, from thieves who were enabled to pursue their vocation in safety, owing to the poor illumination of the wharf. It was not, however, until many years later that the City was induced to adopt arc lighting generally on its streets. The Allegheny plant of the Company also enjoyed a degree of prosperity similar to that of the Pittsburg plant. Shortly following the introduction of the alternating current system in the Virgin Alley plant, six alternating machines were installed and operated with great success in Allegheny.

The advantages of lighting by means of electricity were materially recognized in Pittsburg and the growth of both arc and incandescent business was very rapid. By 1892 the number of incandescent lamps had increased to almost 40,000 and of the arcs to over 1,000. Such an increase demanded a still greater enlargement of the Company's plant. Further expansion on Virgin Alley was impossible so that a new location was found, and the property of the Bradley Foundry Company on Etna Street, between 12th and 13th Streets, was purchased and the old buildings on this site were remodeled to suit the needs of the Light Company.

During the years following, up to 1897, the established rate of growth continued until still further enlargement became necessary and the present buildings used at the Thirteenth Street Station were erected.

The machinery installed in the new station consisted of four 1500 KW two-phase A. C. Generators, direct connected to Vertical Compound Westinghouse Engines of suitable size. These machines were the largest built by the Westinghouse Company up to that time for central station work, and it may be added that they are still in use. Additional and more modern machines have since been built and installed until the present capacity of this plant has reached 9,000 kilowatts.

Owing to the limited range of economic distribution

of current during the early periods of electric lighting industry, many central stations were required to supply the needs of large communities. This condition brought about the organization of numerous electric lighting companies in Pittsburg as well as in other large centers. The first of these was the Electric Light and Power Company, on Diamond Street. This Company was chartered July 14th, 1882, and after operating for a number of years, its entire stock was sold to Mr. George Westinghouse in 1894, but shortly thereafter it became a part of the Allegheny County Light Company's holdings. The next of these companies to be organized was the Pittsburg Light Company of the South Side, which was incorporated August 27th, 1885. This belonged to the Oliver interests and after a limited period of usefulness passed into the control of the Allegheny County Light Company, during the early part of 1887. The most formidable competitor of the Allegheny County Light Company was the East End Electric Light Company, incorporated January 20th, 1886. Sometime prior to its incorporation the Company placed and operated a 5 arc light machine in the basement of a confectionery store at 6202 Penn Avenue in the East End. After a very short period of operation, additional machinery was installed in a building in the rear of this store. Part of this installation was for incandescent lighting, the direct current at 110 volts being used. During the year 1887 the Company adopted the Westinghouse Alternating System and was therefore enabled to include a much larger district in its limits than had been possible before with the direct current. At this time the station was moved from its first location to the location of the present East End Sub-station at Broad and Beatty Streets. The lines of the Company were extended from the plant throughout some of the best residence territory in that part of the city.

As an illustration of the lack of information on the part of the public generally, in regard to electric lighting, it is said that the Board of Directors of this Com-

pany found it necessary to give a considerable part of their time to explaining the merits of electric lighting to their friends and neighbors in order to induce them to make a trial of the new light. Among the first patrons of the Company to use electric light for illuminating their residences, was Mr. Herman Westinghouse, who resided in Edgewood, a distance by the lines, of almost five miles from the plant. Among others, the residences of Mr. George Westinghouse and Mr. H. C. Frick were supplied with light from this plant. The current was distributed at a pressure of 1,000 volts, except the Edgewood circuit, on which the pressure was raised by transformers to 2,000 volts.

There was considerable rivalry between the Allegheny County Light Company and the East End Electric Light Company, especially as to the contracts for city lighting, first one securing the contract for a period and then the other. In both instances, however, the successful Company sublet that portion of its territory, most inconveniently situated, to be lighted by its rival. Finally, early in 1896, the control of the East End Electric Light Company passed to the Allegheny County Light Company, where it has remained ever since. The Central Station at Broad and Beatty Streets was subsequently dismantled and a Sub-station was established in the old building, current being supplied from the Central stations, at Thirteenth Street and Glenwood.

After the absorption of the smaller Companies within the limits of the City, the territory of the Allegheny County Light Company was still further enlarged by securing control of various light and power companies which had been operated in the surrounding suburban districts. Among the first of such companies may be mentioned the Rural Electric Light Company of Wilkinsburg, which passed into the hands of the County Light Company in 1898. In 1902 the territories of the Southern Heat, Light and Power Company and the Monongahela Light Company were added to that of the Allegheny County Light Company and in 1903, the Oak-

mont and Verona Light, Heat and Power Company, and the Ohio Valley Electric Company also passed into the control of the Allegheny County Light Company. Each of these Companies had operated Central Stations, some of which have been remodeled and are to-day supplying current to parts of the general system. Others were dismantled and in their place Sub-stations were established, the Sub-stations being supplied with current from the large Central Stations and each supplying its own district.

The great industries which have made Pittsburg a familiar name all over the world, have brought this district such wealth that the amount per capita is nowhere exceeded in a territory of like dimensions. These industries are of such a character as not only to make the use of electric light necessary, during the daylight hours, but as noted have provided the people with ample means to use it.

The development of electric light and power business in Pittsburg, in the territory of the Allegheny County Light Company, has paralleled closely the development and growth of the industry in general: in many respects it has been ahead of the general development. Many of the first machines and pieces of electrical apparatus, which were originated and have been developed by the Westinghouse interests, were first installed and given practical trial in one or more of the plants of this Company. This is true particularly of such apparatus as is used in the alternating current system. The growth of this Company seems all the more remarkable when the size of the first machines used 25 years ago and the very limited field supplied with current from them are recalled and compared with the machines in operation at the present day, and with vast territory over which its lines are extended. This territory embraces the cities of Pittsburg, Allegheny and McKeesport, and more than 20 surrounding and contiguous boroughs, its total area representing something over 100 square miles. The various power stations operated by

it feed 400,000 Incandescent Lamps (16 candle power or the equivalent thereof), 5,000 Arc Lamps and 6,000 Horse Power of Motors. The development of the system, with respect to the use of electric current, for various purposes, is best shown by the table below:

	INCANDESCENT LIGHTS	ARC LIGHTS	HP MOTORS
1884	75	400	.....
1894	50,000	1,200	100
1904	400,000	5,000	6,000

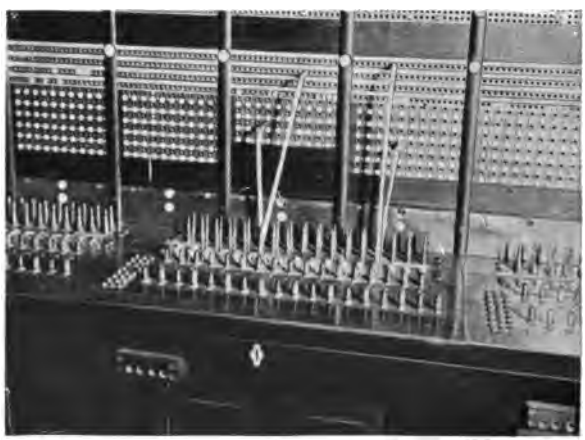
Central District and Printing Telegraph Company

IN the light of the present day the telephone is considered as a necessity in even the smallest towns and hamlets. How indispensable then must the telephone be to a city like Pittsburg, which is divided by natural and political boundaries into numerous districts, many of them small cities in themselves. Transportation in a rugged district such as makes up and surrounds Pittsburg is necessarily slow and tedious, and the demand for instantaneous communication of thought by the telephone is consequently greatly enhanced. This demand for telephone service has been met by the Central District and Printing Telegraph Company, who are the licensees of the American Telephone and Telegraph Company for Western Pennsylvania, Eastern Ohio and Northern West Virginia. It is interesting to note that the Central District & Printing Telegraph Company was originally chartered to exploit the Gray Printing Telegraph. Later, when the telephone was invented this company secured a license from the American Telephone and Telegraph Company to operate in the above mentioned states.

Although telephone service was started in Pittsburg something over twenty years ago by the Bell Telephone Company, it is only within the past ten years that the great advantages of the telephone were realized by the public and the growth in the number of subscribers during this period has consequently been phenomenally great. To-day the Central District & Printing Telegraph Company operates two hundred and two ex-

changes, to which are connected sixty-three thousand subscribers. Of this number about thirty-five thousand are included in what is commonly known as the Pittsburg District, which may be defined as the territory included in a circle struck with a fifteen-mile radius from the point at the intersection of the Monongahela and Allegheny rivers. This company also operates four thousand miles of toll line, connecting the various cities of Western Pennsylvania, Eastern Ohio and Northern West Virginia, thus furnishing a rapid means of communication between all of the immense industries of these districts. In addition to their own toll lines, the Central District & Printing Telegraph Company also connects with the long-distance lines of the American Telephone and Telegraph Company, so that any subscriber in this territory can talk with any of the two million subscribers of the Bell System in the United States.

One of the secrets of success of the great steel industries of Pittsburg, has been their readiness to discard old methods and machinery, just as soon as it was



Detail of Central Battery Board

General View Central Battery Board

demonstrated that better methods and more efficient machinery were available. Fortunately, the same thing has been true of the Central District & Printing Telegraph Company. But a few years ago most of the exchanges of his company were equipped with magneto switchboards, the best of their kind at the time and capable of giving fair service for many years to come. However, the invention of the central battery lamp signal switchboard opened up a way of furnishing great cities with the rapid and efficient service, which was necessary to keep pace with the increase of business and the growing tendency to throw more and more work on the telephone.

Realizing the many advantages to be obtained from this type of switchboard, the Central District & Printing Telegraph Company discarded their magneto apparatus and re-equipped all of their Pittsburg Exchanges as well as many of the exchanges in the outside district with new central battery boards. In the accompanying

illustrations are shown views of one of the most recently installed central battery boards. This switch-board has a capacity for ten thousand telephones and furnishes service to that part of Pittsburg, known as the point. The other central battery exchanges are equipped in a similar manner.

So intimately is the telephone becoming associated with all the every-day affairs of business and social life that telephone engineers hardly dare to predict how great its future may be. Development studies now being made of the Pittsburg District seem to indicate that at least one hundred thousand telephones may be expected in this district by the year 1920. If the present rate of increase keeps up the total number of subscribers in 1920 in the territory of the Central District & Printing Telegraph Company will be over two hundred thousand.

SOME NOTABLE FEATURES OF PITTSBURG

Blooming Mill, showing Ingot on Electrically Operated Buggy, Ready for Rolling Motor-Driven Roll Table and Driving Table at the left

Manufacture of Iron and Steel

THE first blast furnace that paled the sky line of the Pittsburg hills was blown in during the year 1792, and by the year 1812 the manufacture of iron was pretty well established. When later, iron ore of an extremely high grade was discovered in the Lake Superior district, the local deposits of ore in Pennsylvania gradually ceased to be worked; and today practically all of the ore used in the Pittsburg district—millions of tons—comes from the upper lake region, 800 miles away. That the smelting should take place so far from the deposit of ore may seem strange, but it is largely due to the superabundance of rich steaming and coking coal in the Connellsville district adjacent to Pittsburg. And it is because of this fuel that the Pittsburg district today produces a quantity of pig iron which is one quarter of all that is made in the United States, and one-half as much as is made in all England; over one-third of all the steel rails, over one-third of all the steel ingots and castings, two-thirds of all the open hearth steel ingots, one-half of all the crucible steel, two-thirds of all the structural steel and nearly one-third of all the plate steel.

The activity required in producing this prodigious quantity of metal is but slightly portended by the great cloud of smoke that lies over the city by day, and by the fitful flare here and there of flames in the valleys, for Pittsburg lies in valleys cut out by the Allegheny and Monongahela rivers, and the blast furnaces and mills lie close to the water front. From the confluence of the rivers, along up the Monongahela are ranged the furnaces of the Clinton Iron & Steel Co., on

the right hand bank; a mile further, the plant of the Jones & Laughlin Co., which operates six large furnaces as well as mills for structural plate, bar and sheet steel. The well known Carrie furnaces of the Carnegie Steel Co. are on the left bank some six miles further up the river and on the immediate right are the world-famous Homestead mills. Almost directly across from them, but further up at Braddock on the left, are the Edgar Thompson furnaces and mills. The Duquesne furnaces of the Carnegie Steel Co. lie a mile further up the river on the right. Numerous mills and furnaces lie along the Allegheny River as well, and along the Ohio, which is formed by the confluence of the Allegheny and Monongahela rivers. In the marvelous progress of the last century, the development of the iron and steel industry has been a magnificent succession of triumphs over material difficulties. Not the least of these is the evolution of the blast furnace from a small stack 40 or 50 feet high with a capacity of 100 tons per day to a monster smelting tower rising 120 feet and producing 800 tons a day. Another of the solved problems is the speedy handling of material in the course of its manufacture, worked out in many different ways, for many different manufacturing processes. In its solution the electric motor has been applied very generally and its use in that way may be esteemed one of the triumphs of electrical engineering.

The pig iron of the Pittsburg district is refined into various shapes quite diversified, as the steel skeleton of the modern "skyscraper," the massive armor plate of a battleship, or the delicate and finely tempered watch spring and the jeweler's tiny drill. But not all of the material is worked into shape in Pittsburg, and it is the handling of the metal in bulk that may be seen to advantage.

The largest group of blast furnaces in the Pittsburg district is to be found at the Edgar Thompson Steel Works, which are devoted solely to the manufacture of

rails. The site is Braddock, a spot memorable for the defeat of General Braddock by the Indians in 1755. At this place there are now in operation nine furnaces producing sufficient metal to make 2,200 tons of finished rails each day, or enough to lay 12½ miles of track with the heaviest rails that are made — 100 pounds to the yard — an output more than sufficient to single-track the United States from ocean to ocean within the year. Braddock can be reached by the Pennsylvania, Baltimore & Ohio, and the Pittsburg & Lake Erie Railroads, or by electrical cars from the center of the city. Every stage of the manufacture of rails in these works is illustrated by gigantic object lessons.

One of the most potent factors in the development of these works has been the use of electricity. A modern central station now distributes electricity to the various machines formerly driven by small steam engines. In times past steam was supplied through long, leaky pipe lines, the loss of heat by radiation was great and the condensation of water in the pipes troublesome. Now a few slender threads of copper replace the large and cumbersome steam piping and at the end of the transmission line an electric motor supplants the steam engine. The introduction of electricity into rail making, and the substitution of the motor for the steam engine are largely due to the farsightedness of Mr. George Westinghouse. Without adding to its manufacturing equipment, the Edgar Thompson Works has greatly increased its output by using electricity to operate the various metal saws, roll tables, runs, roll conveyors and cranes. Two paramount reasons have governed in this choice — reliability in service and the increased output which has been accompanied with greatly decreased labor costs. Ore is electrically hoisted to the top of the furnace, the metal is poured from the metal cars by a motor, and from the time that the Bessemer ingot enters the rail mills, it is handled thereafter entirely by electricity. It is conveyed to the blooming mill by a motor drive, cut in the shears by a motor,

Electric Locomotive used in Hauling Rails

conveyed to the re-heating ovens and handled in its intricate movements through the various rolls, runs and hot saws by motors. Everywhere electricity is the vitalizing force.

Not very far from Braddock on the opposite shore of the Monongahela is the famous industrial plant created by Andrew Carnegie — the Homestead mills of the United States Steel Corporation. Here we enter the armor plate department where massive steel plates are made for sheathing the battleships of America. Here the armor for the Oregon, Iowa, Brooklyn and Indiana and many other fighting vessels has been wrought. The material is of open hearth basic steel cast into ingots weighing as much as 150 tons, which, by subsequent heating and forging in hydraulic presses of mighty power, are fashioned into ponderous plates.

Homestead is likewise the center of tremendous activity in the manufacture of structural steel. There is scarcely a "skyscraper" on the continent, finished or in process of construction, which does not owe its steel structure to Pittsburg. The steel beams and girders turned out from these mills vary in length from six to

The Motor-Driven Bloom Carriage

ninety feet, and in their manufacture 2.000 men and the most massive and ingenious machinery combine to make the output the largest of its kind in the world. As in the Edgar Thompson plant, the machinery as far as possible is motor-driven and wherever hand labor or the steam drive can be replaced it has given way to the electric motor.

At Homestead also are vast mills for the making of sheet steel for all purposes. And the production of structural steel here and at other mills of the city proper, is of prime importance in the Pittsburg industry, representing nearly 70 per cent of the entire output of such steel in the United States. About 1,000,000 tons, 34 per cent of the total output of basic open hearth steel, is made at the Homestead mills. Nearby are the Carrie Blast Furnaces, as costly and as nearly complete

as any furnaces in the United States. Here are seen all the latest appliances for handling ore in bulk, the traveling bridges for distributing and gathering the ore, car dumpers that pick up a thirty-ton steel car with its load, of fifty tons and invert it at one swing, the stock-yard bins, as well as weighing devices for mixing the burden of a furnace.

The various works of the Carnegie Steel Company are interconnected by railways over which liquid metal for the various blast furnaces is carried for miles from one plant to another.

This economic measure, necessitated by the needs of manufacturing, has led to the establishment of hot metal bridges designed for carrying the heavy metal cars. They are so protected that they are fire-proof and an accident to a metal car will not endanger their integrity, nor be a menace to vessels on the river, nor to persons or vehicles passing under the bridge. The largest of these bridges, and the heaviest in the world for its strength of span, is at Rankin and reaches from the Carrie furnaces to the yards at the Homestead Steel Works.

The iron and steel manufacturing plants of the Carnegie Steel Company in the Pittsburg district include 39 blast furnaces, three steel works with eight Bessemer converters, and 88 open hearth furnaces, five rolling plants with 34 mills, an armor-plate works and a forge works for the manufacture of locomotive and car axles — Cyclopean works worthy of the Homeric archetype! The works enumerated, with the improvements under way and completed, will have an aggregate capacity of 3,430,000 tons of steel per annum, equal to 32.56 per cent of the production of the United States, 12.65 per cent of the output of the world, and nearly 71 per cent of that of Great Britain, measured by her production in 1899, the year in which it was heaviest.

The magnitude of the steel manufacturing operations of the present day, in and about Pittsburg, may be ap-

preciated from the fact that the receipts of raw material and the shipments of the finished product of the three largest Carnegie works aggregate approximately 16,000,000 tons, which about equals the combined tonnage handled by the Missouri Pacific, Southern Pacific and Northern Pacific railways, operating 13,000 miles of track, 1500 locomotives and 50,000 cars. In the mining, transportation and manufacturing operations the company provides employment for about 50,000 persons, and disburses yearly about $50,000,000 to its operative and administrative forces. The amount of business transacted is exceeded by few, if any, commercial organizations in America or Europe.

Out of the depressed steel prices in the early '90s there arose a necessity for handling material cheaply and hence cars are designed and built of steel — steel alone has the required strength — to carry burdens of fifty tons, nearly twice the former and usual capacity. The manufacture of these cars can be most readily inspected at the plant of the Pressed Steel Car Company, on Neville Island in the Ohio River, which can be reached by street cars from the city. This plant can turn out 100 finished steel cars per day.

At Ambridge, on the Fort Wayne Railroad 16 miles from the city, may be seen the largest bridge building works in the world, which have just been erected at that point by the American Bridge Company.

Farmers' Bank Building

The Farmers' Bank Building

ONE of the features in Pittsburg which is most characteristic of its business section, and which in a way shows the remarkable development both in building construction and in the business activity of the city, is its office buildings. There was nothing which could be classed as an office building in the modern sense until the construction, about 1890, of the Westinghouse Building, which had thick walls of brick and was striking at the time of its construction in having the unusual height of nine stories, devoted exclusively to office purposes. Since that time new office buildings have gone up year by year until they form a characteristic feature of the down-town portion of the city. Some of these buildings, in height and size and elegance of appointment, rival any which have ever been constructed. The expansion in the business interests of Pittsburg which has filled these buildings with busy offices is a true index of the development of Pittsburg as a business and industrial center.

One of the most striking of these office buildings is the Farmers' Bank Building.

Fronting one hundred and twenty feet on Fifth Avenue by one hundred and twenty feet on Wood Street, in the very center of the business section, the Farmers' Bank Building occupies one of the most prominent sites in the city. It stands twenty-four stories above the level of the street and has in addition a basement and sub-basement.

In excellence of material and construction, and in elegance of finish, it is equalled by few buildings in the country. The first four stories are constructed of white

marble, the remaining stories of dark brown pressed brick with white trimmings. The interior is finished in mahogany and white marble. Every room has outside windows and the walls are decorated in light colors, giving abundance of light. There are toilet rooms on every floor and lavatories in every office. The steam heating apparatus is of the latest and best, with thermostatic control, and the building is ventilated by means of air shafts and power fans.

Ten hydraulic elevators, equipped with safety devices and run with duplicate engines, furnish a continuous service.

The first floor is occupied by The Farmers' Deposit National Bank, and by store rooms. The remaining floors are devoted to office purposes. On the mezzanine floor under the banking room is the Safe Deposit Armor Plate vault, provided with reception rooms, coupon rooms and all facilities for the prompt and convenient conduct of business.

The building is lighted throughout by Nernst lamps, current for which is supplied by three 150 KW and one 75 KW two-phase 220-volt Westinghouse engine type alternators. This building is the first of its kind to be wholly illuminated by Nernst lamps, and one of the best examples of an alternating current isolated plant in a modern office building.

Frick Building

The Frick Building

THE Frick Building, said to be the handsomest office building in the world, is located at Fifth Avenue and Grant Street.

It rises twenty-one stories above the street level and continues three stories below. The total height of the building, from the engine room floor to the roof, is 265 feet. The building is of the best type of steel construction and this together with the outside walls of granite, insures the highest type of physical construction. Fine Italian marble and Honduras mahogany is used exclusively as the interior finish. All metal work on the main floor, including windows and door frames and main doors to banking brokers' rooms, as well as the elevator grille work and finish of elevator cars, the telephone booths, etc., all located on this floor, are of solid bronze, and the entire effect is one of surpassing beauty.

The offices average in size about 400 square feet and are en suite. They are all light and airy, each office having two outside windows. The average size of the windows is 47 in. x 61¾ in., and in keeping with every detail of the building, the glass is all mirror plate.

The building contains 6,493,592 cubic feet, from engine room floor to roof.

The passenger elevators, of the Otis Hydraulic type of 2,500 pounds capacity at 400 feet per minute, furnish continuous service and the average number of persons carried from 8 a. m. until 6 p. m. is about 28,000; this fact alone is indicative of the "bigness" in every detail of this building. In addition to the ten passenger elevators, one freight elevator and several direct lifts,

complete the elevator installation. Hydraulic power is furnished by one 21 x 34 by 17 x 24 duplex plunger type pump, and as auxiliaries there are three 16 in. x 25 in. by 14 in. x 15 in. slip plunger type pumps.

The Power Plant comprises five 300 HP Babcock & Wilcox water tube boilers, complete with Roney Stokers. Slack coal is used and is dumped into hoppers from the street level and conducted from the hoppers to the boilers by gravity. Four 250 HP Westinghouse Compound Engines, direct connected to 150 KW direct current, 110-volt Westinghouse Generators furnish light and electric power. Two 45 KW motor generator sets furnish current for the 60 glower Nernst lamps, which illuminate the main corridor and banking and brokers' rooms on this floor. There are about 9,000 lights of various candle power installed. Two refrigerating plants of 40 tons each in capacity furnish all ice used in the Union Club and in the Union Restaurant, as well as for cooling 6,000 square feet of refrigerators and all the drinking water. Four fountains on each floor supply specially filtered and cooled water for drinking purposes. The usual quota of smaller machinery, such as house service pumps, of which there are two 14 in. x 8 in. x 18 in. of the duplex plunger type, and boiler feed pumps, of the same type but smaller; the small air pumps for the thermostatic control of the radiators; the vacuum pumps for the heating system; hot water heaters, for the building supply; air pumps for the elevator pressure tanks; ammonia and brine pumps; the mechanical ventilating system for the restaurant; are all contained in the engine and boiler rooms located in the sub-basement and all furnish their portion of the "Thousand and One" details necessary to a plant of this size.

There is also installed a vacuum system for the cleaning of the 636 rooms and this vacuum system is absolute in its cleanliness and besides is perfectly sanitary. All dust is collected in proper reservoirs connected to this system and located in the engine room.

The building is heated by direct radiation. Exhaust steam is used and the supply is sufficient at all times, without the introduction of any live steam whatever. The vacuum system is used and thermostatic valves on each radiator, connected to a wall thermostat in each room, insure an equitable temperature in each room, through the wide range of outside temperature. An average of from two to two and one half pounds back pressure, with a vacuum on the return risers of about 14 inches, serves to circulate the steam thoroughly.

The basement floor is occupied by the Union Restaurant and The Union Safe Deposit Company. The development of the cafe and restaurant rooms is in splendid detail and in keeping with the general tone of the building.

Installed in the Union Safe Deposit Company's rooms is one of the largest and safest of vaults, made of armor plate. The vault is 44 feet long, 24 feet wide and 8 feet high and weighs 892,000 pounds. The front plates are 9 ft. 6 in. x 12 ft. 6 in.; bottom plates 24 ft. 6 in. x 9 ft. 6 in.; side plates 9 ft. 3 in. x 15 ft.; top plates 24 ft. x 9 ft. The thickness of these plates is 6 inches. There are two doors to this vault, of the circular pattern, each weighing 17 tons. Safety devices of the latest practice are installed, thus making this vault absolutely safe from any agency whatever.

The steel for the first pier was set July 27th, 1901, and in less than eight months from that date, tenants were occupying the building.

It is estimated that from 3,000 to 3,500 occupants are in the various rooms during business hours.

The Phipps Power Building

THE Phipps Power Building is located in Cecil Way, 4th Ward, Pittsburg, and occupies a ground space 100 x 100-ft. It supplies light, heat and power in various forms to the surrounding group of properties owned by Mr. Henry Phipps. The building has a capacity of three 1000 KW generators, each driven by a 28x46x48 vertical cross compound engine; four 21½x2—28-in.x6¼x24-in. three cylinder compound pressure pumps for furnishing hydraulic elevator pressure at 850 lbs. per square inch; and 7200 HP high pressure water tube boilers with chain grate stokers.

The generators with their exciting machines, also the elevator pumps, switchboard, superintendent's office, etc., are located on the first, or ground floor, about seven feet above the street, which is well out of danger from high water in this vicinity. The boilers are located, 3600 HP each, on the second and third floors, and above these in the centre of the building is a coal storage bin of 1000 tons capacity. Coal is necessarily delivered to the building by wagon, as no track approach can be had. The building contains two large vertical pumps, drawing their water directly from the Allegheny river and delivering same into the general distributing system at 150 lbs. pressure. There is furthermore an artesian well in the building for supplying drinking water to the various Phipps properties.

The building has been made of sufficient height to give five clear, well lighted floors for renting to light manufacturers, printers and others requiring space of this character. The upper portion of the building is served by two high speed hydraulic passenger elevators,

and one extremely large platform 10,000 lb. capacity freight elevator. Two chimneys are provided, one on either side of the building, each chimney being 11 feet in diameter and extending to a height of 254 feet from the level of Cecil Way; the chimneys are built of plates and are unlined. Coal elevating and conveying machinery and ash handling apparatus are in duplicate, and so installed that a wagon of coal may be dumped through the grating at the Cecil Way entrance, and after being righted, the wagon may receive from an overhead bin a load of ashes.

The entire structure is very substantially built of steel frame work with fire proof floors and walls; foundations are carried about 22 feet below the level of Cecil Way to a solid stratum of river gravel. The coping of the walls is approximately 160 feet above Cecil Way.

Parks and Boulevards

THE visitor who first views the city of Pittsburg in its congested down-town business district is apt to form an erroneous impression of Pittsburg as a whole, as he has not yet seen the wealth of natural scenery, the picturesque surroundings and the points of beauty in which the residence district and environs literally abound. The topographical formation of the city is exceptional and has been the controlling factor in the building of the city.

The Monongahela and Allegheny rivers, by their confluence just in front of the city, form the Ohio. These three have narrow valleys, which on either side are fringed with high hills or precipitous bluffs some 400 or 500 feet in height. Along the river banks and in the tributary valleys are the various factories and industrial works. At "the point" where the rivers unite is an unsymmetrical area measuring scarcely more than a half dozen squares in one direction and 10 or 12 in the other in which the business interests of the Pittsburg district are conducted. Across the Allegheny river lies the city of Allegheny extending back from the river front up over the hills where are found magnificent residences, the beautiful Riverview Park and the Allegheny Observatory.

To the east of the business part of Pittsburg lies a rolling plateau, where once, the geologists say, flowed the Monongahela. The Liberty valley with its surrounding hills is the principal residence portion. On the one side overlooking the Monongahela river is Schenley Park with an area of some 750 acres. This

park was donated to the city by the late Mrs. Mary E. Schenley, whose ancestors were among the earliest settlers. She herself was a native of the city although for many years a resident of London. Ten years ago the present park was partly farm land and partly hilly sides and deep ravines, but with characteristic energy, armies of workmen and gardeners under the supervision of engineers were set to work, roads were built, bridges were constructed, walks were laid and gardens planted, so that within a few years a beautiful park has been developed. Near the entrance to the park is a great conservatory presented by Mr. Henry Phipps, which contains an array of floral specimens which is said to be unsurpassed.

Far away across the Liberty valley lies Highland Park. At the top of a high bluff overlooking the Allegheny river is the reservoir supplied from the pumping station below for the water service of the city. From this height a view up the Allegheny river is most beautiful. On the hill sides skirting the reservoir summit are drives and walks, groves and flower gardens, a

picturesque lake and the zoological garden, a gift of the late C. L. Magee. From the driveways of Highland Park extends Beechwood Boulevard, winding through valleys and over the hilltops four or five miles to unite with the fourteen miles of driveways in Schenley Park. From Schenley Park again extends the Grant Boulevard reaching to the down-town section of the city. These excellent macadamized driveways extending between city and parks and traversing the residence portion of the city are making this the City Beautiful as well as the Smoky City. In addition there are a number of small parks in the outlying districts of the city in various directions.

View at the Confluence of the Monongahela and Allegheny Rivers

Rail and River Transportation

HILE the lavish hand of Nature has placed within the hills of Western Pennsylvania the raw material which make its supremacy as the world's greatest industrial center a possibility, this fact has also been the cause of making the city a point of interest to the student of modern methods of traffic and transportation.

Four hundred and fifty passenger trains leave or arrive in Pittsburg every day. It is in freight traffic that the position of Pittsburg is absolutely unique.

The freight created in the Pittsburg district alone and shipped from here either by rail or river amounts to about 80,000,000 tons per annum. No less than 6,000 freight cars are loaded daily to transport its freight to all parts of the world.

But as Pittsburg is also a large railroad distributing center many thousands of freight cars arrive daily from other points on the greater trunk lines, to be distributed over the smaller railroads. Sixteen railroads converge here, to haul away the tons of freight.

It is scarcely possible to conceive what the amount of such an enormous traffic means, but an idea may be formed when it is considered that the tonnage of the city of Pittsburg exceeds the combined tonnage of London, Liverpool and New York city.

The figures of Pittsburg's tonnage are so stupendous that they are hard to appreciate; that their accuracy may not be questioned, the following extract from a report made by a committee of the Pittsburg Chamber of Commerce, December 16th, 1901, may be of interest. This report was made by men standing high

in the financial, railroad, manufacturing and commercial business of the city. They had been appointed to investigate the cause of the lack of transportation facilities afforded by the railroads, etc., and during this investigation they compiled this statement:

"Beginning with a movement of freight aggregating forty million tons for this district (excluding all freight in transit) seven years ago, the report for 1900 showed an aggregate of over 66,000,000 tons, or, to be more accurate, 2,289,315 cars, containing 57,005,465 tons, were received and loaded while the harbor tonnage of Pittsburg was 8,813,166, aggregating a total of 65,868,631 tons. For the year 1901, about to close, the car service shows an increase of 10 per cent in numbers, and considering enlarged capacity, a conservative estimate of increase in burden would amount to 12½ per cent over that of 1900. Estimating the river and harbor tonnage at 9,000,000, 2,500,000 cars at 64,125,000 tons, you have a grand total in tons of 73,125,000 for the Pittsburg district. While the railroads handled the ascertained traffic last year under great difficulties, it was understood that the maximum had been reached. Instead of this, however, an additional production of 7,125,000 tons demanding transportation, made it impossible to move the freight promptly with the equipment in cars and motive power available."

That report was made three years ago and the growth in the business of Pittsburg has been more phenomenal than ever, the figure quoted therefore at the opening of this article can in no wise be considered an exaggeration.

The river traffic of Pittsburg, besides its wonderful capacity, represents a peculiar feature in the character of the craft employed. The stern-wheel steamboats which ply the Monongahela, Allegheny and Ohio rivers, towing heavy loads, astound the strangers and fill the uninitiated with amazement. The river traffic is made up chiefly of coal from the mines along the Monongahela River, which is loaded into barges and transported

down the Ohio and the Mississippi as far as New Orleans. These laden barges are at first brought into the harbor at Pittsburg, where the shipments are made up. It is not unusual for a shipment to consist of 50,000 tons of coal, loaded in eighteen or twenty barges, securely fastened together and towed down the river by one of these little stern wheel steamers.

This trade is in the hands of coal companies who own their own steamboats and barges, the largest of them being the Monongahela River Consolidated Coal & Coke Co., which operates eighty tow boats, 6,000 coal barges, fifty-six coal mines, and owns 40,000 acres of unmined coal. During 1902 this company alone produced 7,000,000 tons of coal.

Allegheny Observatory

IT MAY seem odd to the stranger that Pittsburg, with her smoke, should be the home of one of the most famous Astronomical Observatories in America. But smoke under certain conditions is actually beneficial, acting as a damper to air currents which would otherwise destroy the evenness of atmosphere and consequent good seeing. This locality is particularly suited to solar study and this branch has always received a large amount of attention at the Allegheny Observatory. The old observatory located on the top of a hill overlooking the two cities, is now completely surrounded by buildings and is about to be abandoned so far as its uses for astronomical purposes are concerned.

It was in this old building that Langley carried on his wonderful work in the exploration of the spectrum way down in the infra red by means of his sensitive instrument, the bolometer. Here also, Langley started his work on aereonautics and concluded a large part of his important determinations. It was in this same old building that Keeler took his wonderful photographs of Saturn's rings.

The new observatory is located one and one-half miles to the northwest of the old one, in Riverview Park, on one of the highest points of ground in western Pennsylvania. In its present location in the center of a public park, no building can ever come near enough to interfere with its efficient operation.

When completed and fully equipped according to the plans of the present director Prof. F. L. O. Wadsworth, it will be one of the most perfect observatories in

America. This beautiful institution has been made possible very largely through the energetic efforts of Dr. John A. Brashear, who has devoted a large part of his time and energies for the past five years to the procuring of funds for it.

The building has three domes, the largest of which is to accommodate a 30-inch refracting telescope, now being built by the John A. Brashear Co. In the northeast dome the Keeler memorial, a 30-inch reflecting telescope donated by the many Allegheny and Pittsburg friends of the late Dr. Keeler, is now being put in place and will soon be ready for service. In the southeast dome will be mounted the 13-inch refracting telescope moved from the old observatory. It is expected that this dome will be devoted mostly to the use of the public under the supervision of a competent astronomer.

The observatory has supplied the time to the two cities and the Pennsylvania railroad for a number of years.

John A. Brashear Co.

A SCIENTIFIC work shop of world-wide reputation, known for the superiority of its production, the place to which the astronomers and physicists of the world bring their rigid specifications for intricate, yet accurate instruments; makers of the most perfect optical surfaces ever produced, are but a few of the good things that can be said of the John A. Brashear Co.

Dr. Brashear started his optical work as an amateur, working at night, doing his polishing on machines of his own make.

He was a mill wright at the time, working in a rolling mill, and his optical work had to be done after the long day of toil at the mill. He was interested in science and particularly in things relating to astronomy. His desire to see and study Saturn's rings was the consideration that started him at work on his first reflecting telescope.

It is worthy of note in this connection, that Dr. Keeler's classic work on Saturn was carried on with apparatus largely made by Dr. Brashear.

The first mirror made required about two years' time, only to be broken while trying to silver its surface. The one following it was completed in as many months. In his early work Dr. Brashear was exceedingly fortunate in having a wife who could sympathize with him in a labor of such proportions and with no great monetary benefit at the end. She frequently attended the engine for him while he was polishing, and later did some polishing herself that was exceedingly creditable.

Soon after Dr. Brashear started his "work shop," as he generally calls it, Mr. James B. McDowell became

Workshop of John A. Brashear Co.

associated with him and has been a most able assistant in all the work turned out by the company.

The greater part of the work is optical in nature, though a certain amount of machine and instrument making is done. The optical parts of the Warner & Swasey binoculars are made in this shop. Large numbers of range finder telescopes have been made for the government in the past few years.

In addition to the above a great amount of special work has been done for observatories and universities all over the world.

A plane surface was recently completed which is perhaps the most perfect plane of its size in existence. It is a circular surface 30 inches in diameter and no part of its surface varies more than a millionth of an inch from the true plane. This plane is to be used in the Allegheny Observatory equipment.

The shop is located in Allegheny at the corner of Perrysville Avenue, this street making an abrupt turn at that place. This factory can be reached from the down town district of Pittsburg by the Riverview Park cars. Dr. Brashear's residence is located near the shop.

Carnegie Institute

ON November the 15th, 1895, Mr. Andrew Carnegie presented to the people of Pittsburg a building erected at the entrance to Schenley Park, intended to provide accommodations for a great public library, coupled with which were a Music Hall, an Art Gallery, and a Museum. The edifice had cost the generous donor eight hundred thousand dollars. Having turned the building over to the authorities of the city, Mr. Carnegie announced his intention of providing an endowment fund of one million dollars, the annual interest upon which was to be applied to the maintenance of the Art Gallery and Museum. The administration of the Library upon the terms of Mr. Carnegie's original gift was vested in a Board of Trustees consisting of eighteen persons, nine of whom represent the municipality through its constituted authorities, the other nine being originally nominated by Mr. Carnegie because of their interest in literature, art, and science and their public spirit. These nine have the privilege, in case of the death or resignation of any of their number, to elect a successor. When Mr. Carnegie came to the act of endowing the Art Gallery and the Museum, he nominated a Board of Trustees consisting of thirty-six, eighteen of whom are the Trustees of the Carnegie Library *ex officio,* and eighteen of whom were friends and acquaintances of his, whom he selected because of their qualifications for the administration of such a trust. These eighteen elect their own successors. The President of the Board from the inception has been Mr. W. N. Frew, the Vice-President Mr. Robert Pitcairn, and the Secretary Col. S. H. Church. The present

Treasurer is Hon. James H. Reed. By action of this Board of thirty-six Trustees, who administer the endowment fund, the name of "The Carnegie Institute" was chosen to designate the foundation.

To the one million dollars originally given as an endowment fund for the Institute, Mr. Carnegie added in 1901 another million, making the total revenue applicable to the maintenance of the Art Gallery and the Museum at the present time one hundred thousand dollars.

Experience showed, shortly after the original building had been thrown open to the public, that it was not adequate in size to the demands which were being made upon all its departments by the public. Mr. Carnegie therefore authorized plans to be prepared for an addition, and he has, as the result of conferences with his friends in the Board of Trustees, given the sum of five millions of dollars for the purpose of enlarging and remodeling the building and furnishing it. The work of erecting this addition, which vastly exceeds in size the original building, is now going on, and contracts aggregating nearly three millions of dollars have been awarded.

Mr. Carnegie, being well pleased with the administration of the affairs of the Art Gallery and the Museum as well as of the Library, resolved to add another feature to the organization known as the Carnegie Institute, and he therefore made an offer, which was accepted by his Trustees, to give them an endowment fund of two millions of dollars for the maintenance of a school which was intended to do for the youth of Pittsburg what is done by the Pratt Institute in Brooklyn. He also offered to erect buildings for this school provided the city would furnish a site. This the municipality agreed to do, and a piece of land contiguous to Schenlar Park and just east of the Institute was purchased in the year 1903. This site has been graded and plans for the buildings are in course of preparation.

It will be seen from the foregoing brief outline of the

successive steps in its development that the Carnegie Institute is a complex of institutions, administered by a Board of Trustees consisting of thirty-six persons. The Library, the support of which has been assumed by the city of Pittsburg, while not a department of the Carnegie Institute, yet is very closely allied with it, and is lodged under the same roof with the Art Gallery and the Museum. The maintenance of musical activities is provided partly by the municipality and partly by voluntary contributions. The salary of the paid organist is derived from the amount annually appropriated by the city for the maintenance of the Library. The Orchestra is maintained by voluntary contributions and by the income derived from the sale of tickets.

The endowment given by Mr. Carnegie to the Institute maintains the three following separate institutions:

I. The Art Gallery.
II. The Carnegie Museum.
III. The Carnegie Technical Schools.

The care of each of these three departments is entrusted to special committees of the Board of Trustees. The Art Gallery is under the care of a committee the Chairman of which is Mr. John Caldwell. The Chairman of the Committee on the Museum is Mr. C. C. Mellor. The Chairman of the Committee on the Technical Schools is Mr. William McConway. An executive officer in charge of each one of these three departments is chosen, to whom the title of Director is applied. He is responsible to the Committee having charge of his department. The Director of the Art Gallery of the Institute is Mr. John W. Beatty. The Director of the Carnegie Museum is Dr. W. J .Holland. The Director of the Technical Schools is Mr. A. A. Hamerschlag. Connected with each of these institutions, and responsible to the respective Directors, is a body of persons possessing the necessary qualifications, who constitute what is known as the Staff of each department. The staff of the Museum consists at the present time of thirty-six persons, scientists and preparators, who are

responsible to the Director, Dr. Holland, for the performance of their various duties. The staff of the Technical schools will constitute the Faculty and administrative force of the schools, the organization of which will be in its outlines analogous to that of other educational institutions. The smallest number of persons employed by any one of the departments is in the Art Gallery, where of necessity but few persons are required.

Since the establishment of Mr. Carnegie's foundation Pittsburg has rapidly advanced to a leading position as a musical centre. The first organist employed was Frederick Archer, and it was determined to give the public two free organ recitals weekly. These recitals take place on Saturday evening and on Sunday afternoon. Mr. Archer also became the conductor of the Pittsburg Orchestra. In this capacity he was later replaced by Mr. Victor Herbert, the well-known musical composer. When Mr. Archer subsequently died he was replaced as organist by Mr. Edwin H. Lemare, who came to the Institute from St. Margaret's, Westminster, London. In Mr. Archer and in Mr. Lemare, Pittsburg has enjoyed the services of two of the most famous organists in the world. In 1904 Mr. Victor Herbert resigned his position as conductor of the Orchestra, and Mr. Emil Paur of Vienna, Austria, was chosen as his successor. Pittsburg is one of the few American cities which maintain a large and well-trained orchestra, and the combined influence of the free organ recitals and of the rendition of the best orchestral music has resulted in the elevation of the musical taste of the community to a remarkable degree.

As the result of Mr. Carnegie's provision of a fine Music Hall has been the elevation of musical taste, so his gift of the Art Gallery has tended to elevate the people of the community in their knowledge and appreciation of the pictorial arts. Annually since the foundation of the Institute an exhibition has been given in the Carnegie Art Galleries, beginning in November and

lasting until January, to which almost all of the great artists of the world have contributed pictures, and in which on occasion have been exhibited, as loans, many of the most important and beautiful paintings owned in America. The annual exhibition of pictures at the Carnegie Institute is regarded to-day as the most notable exhibition of its kind which occurs in America, the standard of quality, so far as the pictures exhibited are concerned, being remarkably high. In the addition to the building of the Institute, which is in process of construction, there will be added to the gallery for the display of pictures galleries for the display of sculptures, photographs, and engravings, and this section of the Institute is intended to do for Pittsburg what is done for New York by the American Museum of Fine Arts.

The Carnegie Museum has rapidly risen to importance among the greater Museums of America, and is to-day regarded as one of the four leading institutions of its kind in the United States. The collections which have been amassed by purchase or by the activities of its staff are very large and very important. It is especially rich in paleontological specimens, some of the most striking collections of a paleontological character in the world being found here. It is also very rich in collections in other branches of science — the collections of birds, mammals, insects and shells being very large and of great scientific importance. The ethnological collections are great. In archæology the Museum holds a high place, and the largest collection of the antiquities of Costa Rica in existence outside of that state is found here. The Museum publishes annually *Annals* and *Memoirs,* and stands in relations of exchange with all the other great museums and scientific institutions of the world.

The Technical Schools have not yet been organized. Preliminary work in the preparation of plans for buildings and for the arrangement of a curriculum is being carried on. No definite time has as yet been set for the formal opening of the Schools to the public.

When the preparation of By-laws for the government of the Board of Trustees of the Institute was undertaken the chairman of the committee in charge of the work inserted a clause calling for the observance of the anniversary of the original gift of the first building as "Founder's Day." This suggestion was heartily approved by the Board, and the celebration of Founder's Day at the Institute has come to be one of the striking events in the intellectual and social life of the city. The occasion has been dignified by the presence of some of the most famous men in America, among them President William McKinley, and former President Grover Cleveland. In November, 1904, the chief speaker will be the Hon. John Morley, one of the leading men of Great Britain.

Carnegie Technical School

EDUCATION of the type and kind existing in the past finds comparatively few adherents willing to devote so long a period in the short span of life to the acquirement of a well-rounded knowledge on all subjects. The trend to-day is towards specialization in education as in business in order that the well-directed energies of each individual may go to produce a more efficient net result and add to the sum total of human knowledge and efficiency.

Mr. Carnegie, impressed with the demand for technical education, needed no prescience to forecast the future of Pittsburg in this demand. He gave expression of his views, with his usual broad philanthropy, by offering an institution to the city of Pittsburg which would provide this specialized instruction. Immediately following the tender of an institution of this character to the city of Pittsburg, with no other request than that suitable land and site should be provided by the city, the offer to equip, endow and perpetuate the Carnegie Technical Schools was received with evident enthusiasm by the Pittsburg community.

The question of an educational organization was placed in the hands of the plan and scope committee of the Carnegie Institute, who, after frequent meetings and consideration of this subject, outlined an institution whose aim and purpose appeared to meet with the approval of Mr. Carnegie.

It is unnecessary to do more than touch upon its scope in order to convey its breadth of purpose and its widespread importance to the entire community.

The Carnegie Technical Schools are to be open to all

those who earnestly desire to receive technical instruction along specific lines and who cannot receive this instruction in any other school in the community. Its pitch or plan is superimposed upon the public system of instruction, the grade, ward and high school, yet is somewhat lower in its entrance requirements, its aim and purpose than the larger universities of the East, making it a unique educational project which is arresting the attention of both educators and laymen throughout the United States.

The plan of operation adopted is largely based upon the report of an advisory committee, which gave much careful thought and study to the question, together with the benefit of their experience in order to determine the character of an institution which would most nearly fit the needs of this community.

Its preliminary developments have thus far taken three lines of progress. After the appointment of its executive and administrative head last November, these three lines of endeavor were prosecuted with the utmost vigor.

In the first place, the educational side received due consideration and thought. One hundred and one scientific lectures were given in Pittsburgh and vicinity during a seven weeks' period, which were attended by over eighteen thousand individuals.

Secondly, consideration was given to the existing demand for technical education. A preliminary canvass of the schools and factories disclosed a student enrollment of over five thousand individuals, who signified their intention and desire to secure technical instruction as soon as some quarters were established.

Lastly, the constructive period necessitated careful study of the existing schools in this vicinity, and the preparation of a program of competition upon which could be based the selection of an architect who possessed the resourceful qualities necessary to carry into execution the building scheme.

During the period when these three distinct matters were being prosecuted it was felt that it would be ad-

visable to present to the public some idea of the character of the instruction to be given. In order to accomplish this purpose a number of public addresses were given. These addresses supplemented by the cordial support of the public press have infused a spirit of enthusiasm and intense interest in both young and old in the projected plans for the erection of this school.

What method will be employed in forwarding the educational movement during the coming winter has not yet been announced. The preparation of plans, the question of temporary classes and the continuation of the lecture course are the subjects of immediate concern and interest to the committee on technical schools at the present time.

It is the present intention to begin only on a scale commensurate with the possibilities of efficient utilization, allowing for expansion as the demand for technical instruction increases. It is proposed that few buildings should be built at the beginning, this to be followed by a gradual growth in the construction of the buildings.

As the educational area becomes utilized to its fullest extent, the next and more important problem to be solved is that of the selection of a faculty capable of administering to the needs of an institution of the character outlined. This faculty will likewise have in charge very largely the equipping of the buildings, great care being taken to have this equipment of such a character that this may be a most modern and complete school.

Its influence is in a large measure dependent upon the virility, character and personality of its staff, and especially is this so of an institution of a scientific character as has been outlined.

Men who have a thorough knowledge of the subject and who have the faculty of imparting that knowledge to others are the kind of teachers needed, but men with character who can wield positive influence upon their students and who have the ability for enthusing the young and the ambitious are not readily found.

When the student realizes that all the school can do

for him is to help him to solve his life problem, leaving it for him to develop his talent, it then becomes necessary that the kind of te_ching given should be of such a character as shall lead him in the most direct way to the accomplishment of the end sought for by his innate desires. Keeping this aim in view, the future course of the student will be guided in a large measure by the advice of his teacher, who will be able in some degree to determine both his capacity and adaptability, and whenever a student shows a lack of capacity or undecided attitude it is hoped that the personality of the teacher will be sufficiently strong to guide him to safe and sure points of interest which will lead to his ultimate advancement.

The fields in which the graduates of an institution of this character will prove useful are too many to enumerate with minuteness, but they should in a comparatively short period demonstrate to the community the need for instruction of this character and prove of undoubted value in a much wider sphere of influence.

Graduates should find ready and waiting for them places in all the manufacturing, building and scientific industries of the country; some of them as apprentices, others as journeymen of greater skill and capacity than the past generations have produced, of foremen, superintendents, managers, assistant engineers and architects.

The women graduates should find places as wage-earners, secretaries, librarians, and costume designers with a thorough knowledge of domestic art and science, whether dealing with plain design or the utilization of the common necesssities of life, all finding their training to have been so sound in fundamental principles that after a reasonable amount of experience and practice they can become leaders in the lines which they have selected.

The subject of civics, pride of city and home, is one to which too little weight is given by the average technical school. It is expected that the high character of

the members of the faculty of this institution will have its influence socially and that breadth of view and wide discernment as to the relations of the individual to the community will best find expression in the graduates who have been under the guidance of high-minded, purposeful men and women.

It is in an ideal such as this, a philanthropy which recognizes and assists those with capacity. virility, knowledge and enthusiasm, that a broad and munificent gift such as Mr. Carnegie's can best find its expression.

The following proposed groups of buildings will convey a clearer description of scope of the undertaking and of the four distinct schools projected:

Administrative Group.—The Administrative Group should be so designed as to house the executive department of the Institution, make provisions for the social development of the students, and provide an auditorium for the assemblage of the entire School.

School of Applied Science.—This group must be designed to administer to the needs of a School of Applied Science, operative for both day and night students, and for the training of young men over sixteen years old during periods of two or three years, for such callings as Draughtsmen, Inspectors, Foremen, Engineers' Assistants, and numerous other positions above those of the skilled mechanic, where intelligence and technical information are more essential than manual dexterity.

In this School a large part of the instruction, including that in shop work, will be given in Laboratories, Draughting Rooms, etc.

To make this instruction thorough and effective the entire equipment must be of the most modern type. The machinery and appliances will be of such a character and so used that an economic use of both labor and material can be demonstrated in a manner similar to that found in the commercial shops.

In the arrangement of the various class rooms, laboratories and shops of this Group, the principal object sought should be close correlation.

The School for Apprentices and Journeymen.—This Group should be adapted to the night instruction of students. The School for Apprentices and Journeymen will offer a system of instruction for the further education of apprentices already at work in the trade, who will receive at night technical and theoretical information, coupled with a fair amount of that practical demonstration necessary to their ultimate advancement into the ranks of skilled mechanics. The object of this night instruction is to supplement the daily practice of the apprentices, but it must not be supposed that this School will in any sense endeavor to turn out skilled mechanics. The students, upon completing this course supplemented by their daily apprenticeship, would necessarily continue to serve the balance of their time in commercial operations, prior to their being ranked as skilled mechanics.

This School Group will also provide for the education and training of those mechanics in the building and manufacturing trades, who are already rated as journeymen, giving them an opportunity to supplement and develop their intellectual powers, so that they may relatively keep in advance of the apprentice and find a wider opportunity for their skill, experience and knowledge of their subject, which will insure to them further advancement to positions such as foreman, superintendents, master mechanics, etc.

The course of instruction in the School for Apprentices and Journeymen will be so arranged that the students will have an opportunity to acquire familiarity with materials, knowledge of the basic principles employed, and of the mechanical and working drawings, elements of physics and chemistry and a familiarity with new materials and the most modern tools.

The instruction must be accurately based on the standard demanded in the skilled labor market, and must be constantly adjusted to conform to the changing conditions demanded in the various industries, consequent upon the use of new materials and new methods of manufacture or construction.

The shops, laboratories and class rooms required for this School Group will therefore be equipped in the most complete manner, so that the practical, as well as the theoretical, part of the instruction may be at all times closely related to the best practice in commercial work. The arrangement between the shops, class rooms and draughting rooms should be such as to permit the closest possible correlation in the work carried on in these sections.

Technical School for Women.—This Group should be designed to house a technical school for women, giving instructions to both day and evening students. The School will be strictly practical in character and will have for its principal aim the training of women to earn their livelihood. Its purpose will be to give to them a technical training or special skill in various subjects, which will increase their earning power.

It will offer courses of two grades:

First: Short courses of the trade character adapted to those of comparatively limited natural ability and previous intellectual training, to enable them in the shortest possible time to become skilled workers.

Second: Longer and more technical courses for mature women with more intellectual ability, to fit them for more responsible and remunerative positions. These courses will be about three years in length.

There will, therefore, be needed in this School, for the practical instruction which is intended the kitchens, laundries, etc.; work rooms for millinery, dressmaking, etc., and special laboratories or shops, carefully designed for the purposes indicated, and in accordance with the best precedents found in hospitals, hotels and commercial establishments.

Evening instruction will be of the same practical character as that given in the day courses.

School of Applied Design.—This School should be designed to accommodate classes in the design, technique and mechanical processes of the various Art Industries specified. The purpose of the School will be

to instruct those who aspire to become skilled workers as well as designers after a reasonable amount of experience, who are familiar with the technical requirements of these industries.

There will be needed to accomplish this purpose, well equipped work rooms, where the students can apply the designs which they have created, under conditions closely resembling those that they will find later in commercial work of like character. The principal part of the instruction will be of this practical character.

There will be given in this School, instruction in both day and evening classes.

If these aims above set forth can be accomplished it is needless to comment upon the ultimate widespread usefulness of this institution in developing not alone its own character and growth, but serving as a medium for developing the character of the entire Pittsburgh community.


CLEVELAND


Sharpsburg
Guayasuta
Aspinwall
Etna
Allegheny River
HIGHLAND PARK
East Liberty Sta.
Millvale
Bennett Sta.
ALLEGHENY CEM.
Roup Sta.
Shady Side Sta.
Lawrenceville Sta.
25th St. Sta.
PITTSBURGH
Carnegie Library
SCHENLEY
Schenley Hotel
Union Sta.
R. D. NUTTALL CO.
NERNST LAMP CO.
WESTINGHOUSE BUILDING
Monongahela
Jones & Laughlin Iron Works
B. & O. Sta.
P. & L. E. Sta.
PENN.
Knoxville
ALLEGHENY
M. & N. WORKS